# WATER SUPPLY IN ISLAMABAD

CAPITAL DEVELOPMENT AUTHORITY
ISLAMIC REPUBLIC OF PAKISTAN

# PRE-FEASIBILITY REPORT

OCTOBER 1970

PREPARED BY
OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN
AND
JAPAN SURVEY TEAM OF WATER SUPPLY IN ISLAMABAD

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# PREFACE

The Government of Japan, in response to the request of the Government of Pakistan, decided to extend its assistance in conducting pre-feasibility study for the water supply project of the City of Islamabad, newly created Capital of the Republic, in its overall development programme of the City, and the Overseas Technical Cooperation Agency was entrusted to undertake its implementation.

In view of the significance of the work proposed, the Agency organized a survey team of 7 members headed by Mr. Katsumi Yamamura, Deputy Chief, Water Works Section, Environmental Sanitation Bureau, Ministry of Health & Welfare, Japanese Government, and sent the team to the City for the duration of 70 days from 12 February 1970, for the purpose of collecting necessary data and performing field survey, in order to undertake evaluation of the current situation and the establishment of urgent programme necessary for immediate action, together with the master plan of the water supply system up to the year 2000.

The present report is the outcome of the work of the team, both at Islamabad and Tokyo, including recommendation for immediate action and the future development. It is hoped that the report will prove to be stimulus and serve as useful in taking required action, and will, at the same time, contribute to the furtherance of friendship between the Countries of Pakistan and Japan.

Government agencies of Pakistan, particularly the Ministry of Economics and the Capital Development Authorities, have extended their most cordial cooperation to us throughout our undertakings, and it is our pleasure to express our since appreciation to them at this occasion.

October, 1970

K. Tatsuke

Keiichi Tatsuke
Director-General
Overseas Technical Cooperation Agency

## LETTER OF TRANSMITTAL

Mr. Keiichi Tatsuke,
Director-General,
Overseas Technical Cooperation Agency,
Tokyo, Japan.

Dear Sir:

We, the Survey Team on Islamabad Water Supply Project, have great pleasure in submitting herewith the pre-feasibility report of the water supply system of the City of Islamabad. The terms of reference of the Team was to establish basic plan for the water supply system at the newly established capital of the Country up to the year 2,000, and we are confident that the present report as submitted shall make valuable contribution to the implementation of the future development scheme of the City.

The report contains the long range plan, divided into the 1st stage which describes the work to be carried out on Simly Line to meet the requirement up to the year 1985, and the 2nd stage for Kampul Line up to the year 2,000, with preliminary designing, financial planning and the urgent supply programme to meet the immediate requirement, together with the programme for the control of leakage.

Detailed consultation in finalizing the report was undertaken by three members of the Team with the Government of Islamabad while it was still in the form of the draft. The earnest desire was expressed, during the occasion, by the people concerned in the Government of Pakistan, that the continued assistance, both technical and financial, for the improvement of Islamabad water supply system should be provided by the Government of Japan. Your due attention on this matter shall therefore be greatly appreciated.

In submitting this report, we should like to express our sincere appreciation to the following agencies who have so generously extended their assistance and cooperation during the course of our undertakings:

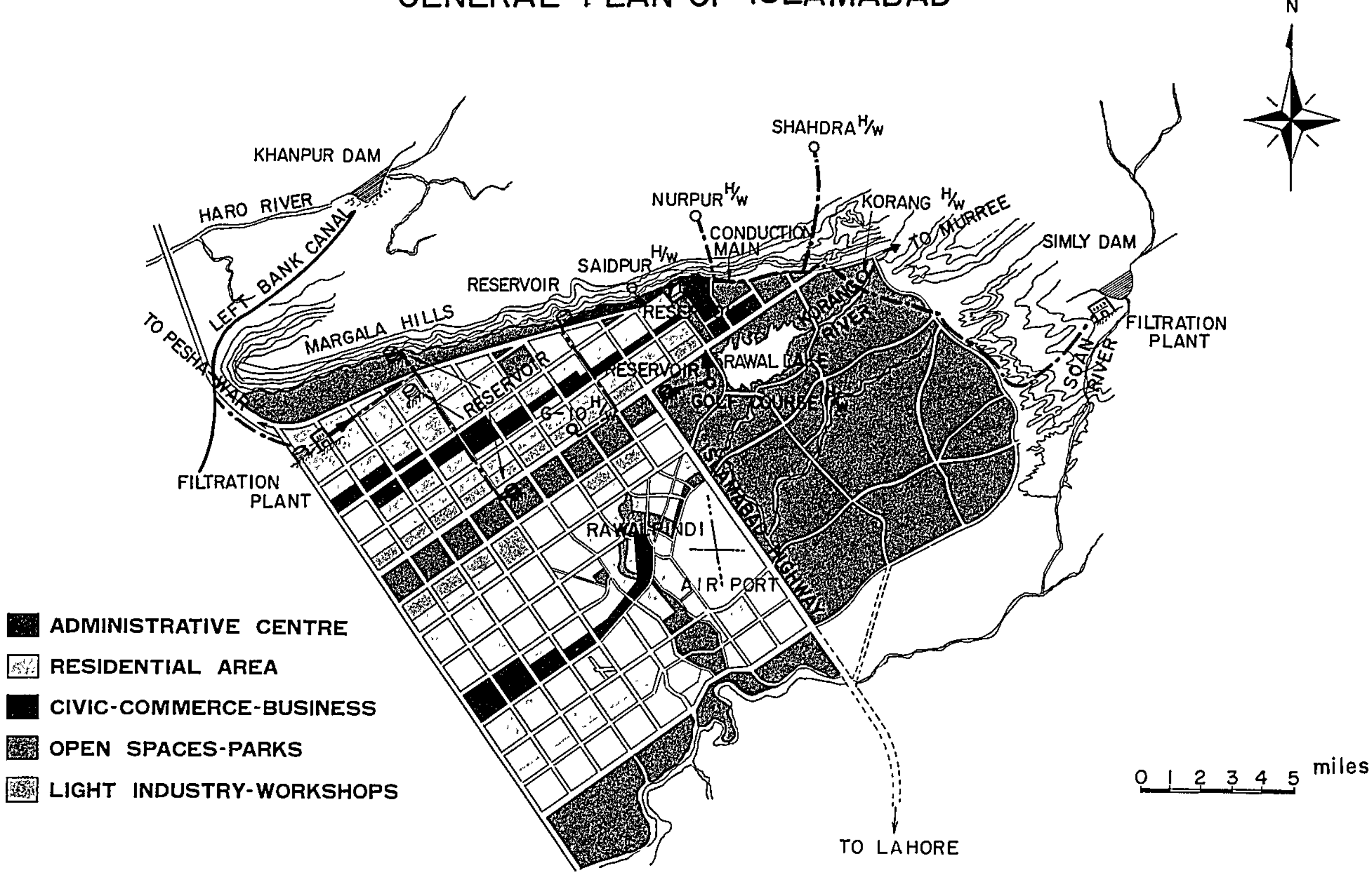
Government Agencies of Pakistan, Embassy of Japan at Islamabad, Ministry of Foreign Affairs, Ministry of Health & Welfare, Overseas Technical Cooperation Agency, Japan Water Works Association, Federation of Japan Water Industries, and Nihon Suido Consultants, Ltd.

October, 1970

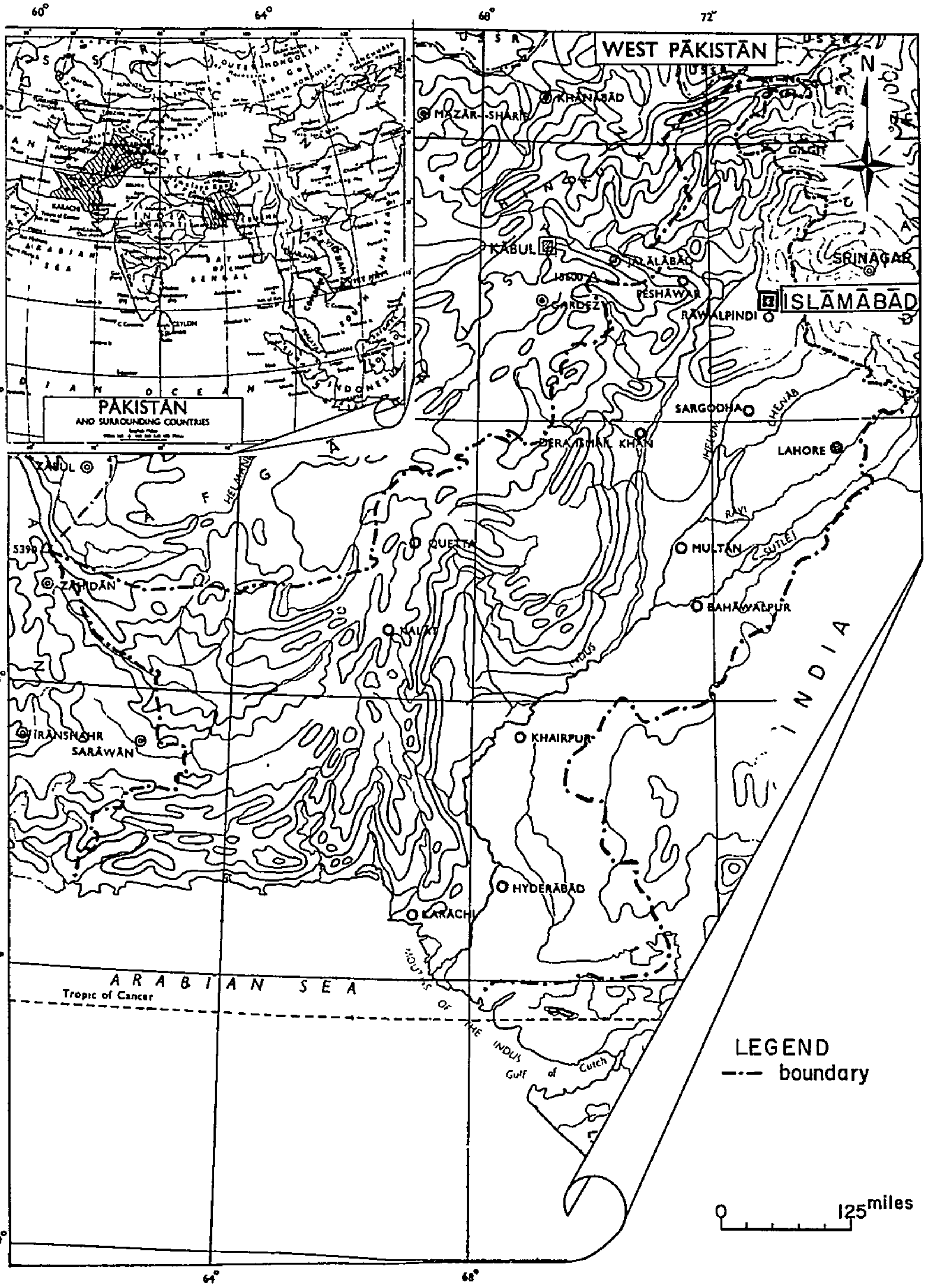
K. Yamamura

Katsumi Yamamura,
Team Leader,
Deputy Chief, Water Works Section,
Environmental Sanitation Bureau,
Ministry of Health & Welfare,
Japanese Government.

# GENERAL PLAN OF ISLAMABAD



# KEY AND LOCATION MAP



## Basic Information of Islamabad

Islamabad means the home or the citadel of Islam. It was in October, 1961 that the first spade was struck on the ground to mark the commencement of a gigantic task to build a National Capital City for the nation of Pakistan.

Islamabad is located at the foot of the Murree Hill immediately adjacent to the North and East of Rawalpindi and forms the north-eastern part of the Potwar Plateau. The hills of the capital plateau area vary from 1,700 feet in elevation near Rawalpindi to 2,000 feet at the foot of the hills. The area is drained by the tributaries like Korang, Gumrah Kas, Soan, Lei and Sangjani of Soan river. Rawal Lake is situated in the middle of the Capital Area. The area enjoys a pleasant climate and good communications and is rich in building materials.

- Salient features -

| | | |
|---|---|---|
| Location: | latitude | 33°38' - 49' |
| | longitude | 72°50' - 73°24' |
| Total area: | Islamabad capital site - 350 sq. miles | |
| | Islamabad proper - 162.1 sq. miles | |
| Topography: | Undulating ground rising gradually forms an elevation of 1,650 feet to 2,000 feet above sea level | |
| Geology: | Four different units of rocks have been indented in Islamabad and adjacent area. | |

i) Sandstone and limestone of Cretaceous age.

ii) Hill limestone of Eocene age.

iii) Sandstone, clay, shale, claystone, siltstone and thin layers of limestone and conglomerate of Lower Pelistone age.

iv) Deposite of Pleistone and Recent age.

Temperature and Rainfall:

| | Temperature | | | | Average Rainfall | |
|---|---|---|---|---|---|---|
| | Maximum | | Minimum | | | |
| | °F | °C | °F | °C | Inches | mm |
| January | 62.4 | 16.9 | 37.8 | 3.2 | 2.50 | 64 |
| February | 65.8 | 18.8 | 41.8 | 5.4 | 2.24 | 57 |
| March | 75.3 | 25.1 | 50.5 | 10.3 | 2.71 | 69 |
| April | 86.6 | 30.4 | 59.5 | 15.3 | 1.94 | 49 |
| May | 97.9 | 36.6 | 69.0 | 20.6 | 1.25 | 32 |
| June | 103.7 | 39.8 | 76.1 | 24.5 | 1.79 | 45 |
| July | 97.7 | 36.5 | 77.1 | 25.1 | 8.33 | 212 |
| August | 93.6 | 34.4 | 75.4 | 24.1 | 9.83 | 249 |
| September | 93.4 | 34.1 | 69.6 | 20.9 | 3.99 | 101 |
| October | 88.5 | 31.4 | 57.5 | 14.2 | .91 | 23 |
| November | 77.5 | 25.3 | 44.5 | 7.0 | .49 | 12 |
| December | 67.0 | 19.5 | 37.9 | 3.3 | 1.09 | 28 |
| Annual | 84.1 | 29.0 | 58.1 | 14.5 | 37.07 | 941 |

Note: From record of Meteorological Department for Rawalpindi, 1875/1965

## Unit and Conversion of Unit

| | | |
|---|---|---|
| US$1.00 | : | Pak. Rs. 4.76 |
| Pak. Rs. 1.00 | : | US$0.21 |
| Cusecs | : | Cubic feet per second |
| Gallons | : | Imperial gallons |
| gpd | : | Imperial gallons per day |
| gpcd | : | Imperial gallons per capita per day |
| mgd | : | Million imperial gallons per day |
| °C | : | Centigrade |
| °F | : | Fahrenheit |
| ppm | : | Part per million by weight |
| pH | : | Potential of Hydrogen |
| Rft | : | Running feet |
| ø" | : | Diameter of pipe (inch) |
| EL | : | Hight above mean sea level |
| FEC | : | Foreign exchange component |
| CDA | : | Capital Development Authority |
| CIP | : | Cast iron pipe |
| DCIP | : | Ductile cast iron pipe |
| PRCCP | : | Pre-stressed reinforced cement concrete pipe |
| RCP | : | Reinforced cement concrete pipe |
| PVC | : | Polyvinyle chloride pipe |
| sq | : | Square |
| ft | : | Feet |
| hr | : | Hour |
| sec | : | Second |
| HP | : | Horsepower |
| lb | : | Pound |
| M | : | Miles |
| m | : | Meter |
| mg | : | Million gallons |
| kw | : | Kilowatt |
| KVA | : | Kilovolt-Ampere |

Pre-Feasibility Report on The Water Supply

in Islambad, Pakistan

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# CHAPTER 1

# INTRODUCTION

# CHAPTER 1

# INTRODUCTION

## 1.1 Services of Japanese Water Supply Engineers

The city development of Islamabad has been carried out by Capital Development Authority (CDA), since the city was decided as the new capital of Pakistan in 1960.

Regarding the development of water supply system, Saidpur and Nurpur Head Works were constructed by the designs of Doxiades Associates, Greek Engineering Consultant, who worked for city planning of Islamabad, and water has been supplied from these places. Since then, the city has constructed several head works around the small rivers near the city for the water demand of increasing population, but the supply has never been able to meet the need and the scarcity of water still remains acute. Simly Filtration Plant with the capacity of 24 mgd was constructed by German aid in 1965, but a plant has not been used to full capacity because the Simly Dam, the water source for the Plant has not yet been constructed.

The Government of Pakistan asked Japanese Government in January, 1970 to provide services of water supply engineers and to undertake the feasibility study of water supply plan both for urgent and future extension works. In response to the request, Overseas Technical Cooperation Agency of the Japanese Government (OTCA), dispatched The Japan Survey Team consisting of 8 engineers headed by Mr. K. Yamamura, Deputy-Chief, Water Works Section, Ministry of Health & Welfare.

## 1.2 Purpose and Scope of Investigation

The main purpose of the study is to investigate the present situation of water supply system in Islamabad, including the survey on consumption and production of water, existing head works and other related facilities including water meters, and to make the pre-feasibility report both on urgent works and future plan.

The report, accordingly, includes the study of existing system and future plan. Financial projection for future plan is also carried out. It is regretted however that the sufficient data were not available during the survey and the further attempt has to be undertaken for the details of implementation of the plan.

## 1.3 Survey and Study

### 1.3.1 Field Survey

The field survey was conducted during 70 days of the Team's stay at Islamabad, from February 12 to April 22, 1970, by the following eight engineers:

| | | |
|---|---|---|
| Chief: | Katsumi Yamamura | Deputy Chief, Water Works Section, Environmental Sanitation Bureau, Ministry of Health & Welfare. |
| Deputy-Chief: | | |
| | Shigeyuki Okamoto | Chief, Planning Division, Sapporo Municipal Waterworks |
| Member: | Shigeki Nakajima | Registered Consulting Engineer, Nihon Suido Consultants Co. |
| Member: | Tamaki Nakadonari | Registered Consulting Engineer, Nihon Suido Consultants Co. |
| Member: | Yasuo Matsuura | Assistant Engineer, Waterworks Department Nihon Suido Consultants Co. |
| Member: | Shoji Sasaki | Assistant Engineer, Water Works Department, Nihon Suido Consultants Co. |
| Member: | Yoshio Nakahira | Coordinator, Development Survey Division, OTCA |
| Technical Advisor: | | |
| | Hiromu Tanabe | Doctor of Engineering, President, Nihon Suido Consultants Co. |

### 1.3.2 Preparation of Report

Nihon Suido Consultants Co., Tokyo, who provided majority of the field survey team, was commissioned by OTCA to prepare the report under the supervision of Mr. K. Yamamura, Chief of the team.

## 1.4 Source of Data

Followings are the various data for the study collected at CDA and other Government organizations in Islamabad.

1. Aero-topographical map on the scale of 1:50,000 with contour intervals 50 feet published under the authority of A. R. Qureshi, Surveyor General of Pakistan, with the title of "Master Plan of Islamabad Metropolitan Area" in 1963.

2. Mass curve of stream flow at Simly Dam Project by Directorate of Designs, Water and power Development Authority.

3. Report on Hydrology & Surface-water Resources of Federal Capital Area, May 9, 1960 by Tarbela Dam Project, Water and Power Develop-

ment Authority.

4. Geohydrology of the Federal Capital Area (Islamabad) West Pakistan, Bulletin No. 13 in 1966 by Water and Soils Investigation Division, Water and Power Development Authority.

5. Ground Water Investigation Report, Part-1 Islamabad, August 30th, 1966 by c/o DW & Chief Engineer, Karachi.

6. Alternate Studies for Water Supply to Islamabad, August, 1962, by Associated Consulting Engineers (ACE) LTD. Karachi.

7. Islamabad Bulk Water Supply Feasibility Report, November, 1968, by Tecsult International Limited, consulting Engineers, Canada.

8. Simly Dam Project, Design Memorandum No. 4, October, 1969, by Directorate General (Design), Water and Power Development Authority.

9. Water Supply to Islamabad by Mr. C. J. Price, National Capital Development Commission, Canberra, 1968.

10. Summary on Water Supply to Islamabad by Deputy Director (Water Division), Capital Development Authority.

11. Population Projection of Islamabad - A Preliminary study, 22nd October, 1969, by P. P. & H. Section, Planning Commission.

12. Report on Population Projection and Water Need for Islamabad, November 1st, 1969, by Director Planning, Capital Development Authority.

13. Results of Water Quality Prepared by National Health Laboratory, Islamabad.

14. Pakistan Year Book 1969.

CHAPTER 2

# SUMMARY AND RECOMMENDATION

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# CHAPTER 2

# SUMMARY AND RECOMMENDATION

## 2.1 Present Situation

### 2.1.1 General

Since the beginning of the city planning and construction work which started in 1961 for the City of Islamabad, CDA has endeavored to provide sufficient amount of water to the City. However, the increasing needs are so rapid that the supply has never been able to satisfy them. The maximum capacity of the supply in drought season of 1969 is 5.0 mgd while the peak consumption is estimated to be 11.25 mgd, indicating the existence of fairly long period of shortage of supply within the year. The fact is, that there exists almost cronic shortage of water supply all through the year, because of the added difficulties of the followings in addition to the shortage of supply itself.

a) The survey conducted shows that fair amount of supply is lost due to the leakage on the conduction mains, distribution pipe lines and the broken valves.

b) Insufficient pipe lines for the distribution net work is causing uneven distribution of supply to all the areas covered by the existing system.

c) House meters are not working correctly due to several reasons and together with the inadequate current tariff system for water consumption, this seems to be inviting the wastage of water by the consumers.

It is natural therefore that action has to be taken immediately on 1) leakage control, particularly on Simly mains and the distribution lines, 2) rehabilitation of pipe lines including valves, to ensure the even distribution, 3) wastage control by enforcement of meter system and other related program. It should be emphasized however that the basic consideration required should be how to increase the supply itself and the completion of Simly Dam which has so long been contemplated should be given serious attention, since that alone can solve the problem of shortage of water to the City of Islamabad.

### 2.1.2 The Existing Head Works

Since the existing head works are scattered in several places, all of which are small capacities, their operation control and maintenance are extremely difficult and they are in no way sufficient as water sources for the capital city of Pakistan aiming at a population of 800,000.

In addition to these disadvantages, there is found overestimating capacities of each head works, the fact that the capacity of the existing head works has been estimated on normal water discharge of the water sources. The discharge of the water sources will decrease to as low as 30% of the normal water discharge in drought seasons when the day consumption reaches to a maximum. Unless regulated by reservoirs, the capacity of head works should therefore be planned on the basis of drought season discharge and the current estimation of the existing head works is therefore not justified.

The water production capacity of the existing head works is about 17.55 mgd but they can supply 5 mgd only in a drought season of 1969.

The new Golf Course head works and G-10 head works, both of which are under construction, have a capacity of 2 mgd each. The existing Golf Course head works with a 2 mgd capacity and the existing pumping station of G-10 head works supplied water of 1.0 mgd and 1.2 mgd, respectively, in June of the 1969 drought season. In the case of the G-10 head works, as raw water is pumped up to Saidpur head works from the existing pumping station, its water production may not increase even if the new head works is completed there. The new Golf course head works supplied water in the drought season while its construction was not finished. But the yield of its source wells has not yet been measured.

The Simly Filtration Plant with 24 mgd capacity was completed in 1965, and one ø36" conduction main pipe from the plant to Islamabad was laid in 1967. The survey of the proposed Simly Dam on Soan River for the water source of this filtration plant was completed on April, 1970 but its detailed designing with specification and tender documents for procurement of materials have yet to be prepared.

As a provisional step, therefore, a temporary pumping station was installed on a Soan River side, from which water has since April, 1969 been transported through the Simly Filtration Plant to Islamabad at the rate of 5.5 mgd maximum and 2.0 mgd average. This means that the Simly Filtration Plant is operating half a day only, handling water of 22% of the design capacity of Filtration Plant (24 mgd), namely 5.5 mgd.

### 2.1.3 The Conduction Main and Distribution Network

On the Simly Conduction Main, the Japan Survey Team conducted reconnaissance in the area from Islamabad to Simly Filtration Plant during the period from 17th to 24th March, 1970. The field survey revealed that water leakage exposed on the ground surface was 1.26 mgd and amounted to 50% of the water discharge transported from the Plant to Islamabad. The pipe used in the Simly Conduction Main is a locally-made prestressed concrete pipe with steel coating and has sufficiently high strength. However, it is clear that water is leaking from many joints because of the welded joints which are low in strength, not protected by corrosion proof painting or by jute winding after welding, and also of the incomplete earth-filling when the pipe was laid.

The water of the main at Gumreh Kas River is more than 450 feet in water hight and the surge relief valve installed there operates at a pressure of 150 psi (350 feet) to discharge water through a ∅6" valve. The records of pressure gage at the field on the 22nd March, 1970, registered as follows:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hours | 4.00 | 6.00 | 8.00 | 10.00 | 12.00 | 14.00 | 16.00 | 18.00 | 20.00 | 24.00 |
| Pressure | 145 | 150 | 150 | 150 | 150 | 140 | 145 | 150 | 150 | 150 |

It is considered from these data that wastage occurred almost all day.

There are many in-flow points to the distribution pipe nets since head works of small capacity are scattered. Water is supplied according to the time schedule for their own areas because of shortage of water and this has resulted in very complicated valve operation at the in-flow points from head works.

At the time of the survey, many visible leaks on the ground surface were found and more than 50% of the valves were out of order. Most of the valves were without spindles and timber-made wedges were placed instead but they were too loose to stop leakages.

#### 2.1.4 The Existing Water Meters

Polish made water meters have been installed at 10,248 of the existing 10,788 service connections. The Japan Survey Team checked 60 sets at random, finding that about 50% of the meters checked were out of order.

The main cause of faulty water meters is incomplete materials and mechanism of the gear box transmitted to the dial board, which can only be replaced with complete sets.

No water meter shop with complete facilities of overhaul machines, washing tanks, shot blasting machines and air compressors is yet provided. For the sound management of water supply it is essential to maintain accurate metering. And defective meters must be repaired and calibrated at the well equipped meter shop.

### 2.2 Need for Action

#### 2.2.1 Future Population and Water Demand

The following future projection is arrived at as a result of surveys and studies on the water supply in Islamabad on the basis of which the proposal for action is recommended.

1) The future population in Islamabad is estimated on the basis of annual growth rate of 10.9% in 1970 and gradually decreasing to 4.1% in 2000 with amendment detailed in paragraph 4.1.3 Future Population as shown in the following: -

| Years | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|
| Population | 75,000 | 150,000 | 225,000 | 400,000 | 512,000 | 638,000 | 768,000 |

2) The average water consumption in Islamabad is calculated by year as follows: -

| Years | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|
| Actual demand gpcd | 50 | 53.3 | 56.8 | 60.5 | 64.4 | 68.6 | 73.1 |
| Percentage of leakage and wastage | 50 | 44 | 37 | 33 | 24 | 19 | 14 |
| Actual demand after allowing leakage and wastage above. gpcd | 100 | 95 | 90 | 90 | 95 | 85 | 85 |

(The percentages of leakage and wastage by year are the estimated rate of unaccounted-for water).

3) The average day demand for Islamabad at the moment is 100%, maximum day demand is 150% and maximum hour demand is 300%, but in future with the increase of the population, the maximum hour demand will decrease from 300% to 250%.

4) The total water demand by year in Islamabad are shown as follows: -

| Years | | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|---|
| Served Population | | 75,000 | 150,000 | 225,000 | 400,000 | 572,000 | 638,000 | 768,000 |
| Average day Demand | gpcd | 100 | 95 | 90 | 90 | 85 | 85 | 85 |
| | mgd | 7.5 | 14.25 | 20.25 | 36.00 | 43.52 | 54.25 | 65.25 |
| Maximum day Demand | gpcd | 150 | 143 | 135 | 135 | 128 | 128 | 128 |
| | mgd | 11.25 | 21.45 | 30.38 | 54.00 | 65.54 | 81.69 | 48.26 |

### 2.2.2 Proposed Action

The existing head works were installed at water sources of small capacity located in the City of Islamabad and its suburban areas as the needs increased, from which water has been supplied. As a result, there remains no more water sources which can be used for water supply in and around the City of Islamabad

The maximum day consumption is estimated to be 11.25 mgd in the year 1970 when the population of Islamabad is about 75,000. According to the current records, even though it may not be reliable, water sources where the existing head works are located are estimated to provide a monthly discharge of only about 5 mgd in the drought season. Thus, the drought water discharge of the existing water sources is far less than the estimated maximum day demand.

To solve such shortage of Islamabad water supply, it is necessary to complete the construction of Simly Dam that will permit seasonal regulation and secure discharge of 24 mgd in the drought season. For this reason, the dam construction should be started as soon as possible -- while it must be noted that it will take at least three years to complete the dam.

The conclusion of the Japan Survey Team is that there is no drastic immediate solution for water supply shortage until the year 1973 when the dam is expected to be completed.

However, while the additional supply depends only on Simly Dam, the present situation of water shortage can be eased to great extent by rehabilitating the existing water supply facilities.

First, all the leakages of the Simly Conduction Main should be repaired. Rehabilitation of Simly Conduction Main from the present leakage amounting to 1 mgd or more will require cost much lower than the construction cost of the new Golf Course Head Works.

The next step should be to rehabilitate distribution pipes from visible leakage by replacing broken valves and valve spindles and also covering the leaking points with specially designed caps. This will permit the pipes to be protected against 10 - 15% leakage and wastage, meaning that a head works equivalent to the Korang Head Works will be installed at a lower cost.

## 2.3 Recommendation

### 2.3.1 Construction Program

Based on the conclusions as stated above, the following recommendation is hereby submitted.

1) Rehabilitation Works (1970)

Rehabilitation work on existing facilities will contribute to a great extent to increase the amount of supply to the communities. First, all visible leakage on the main and the distribution pipes should be repaired.

Second, water meters should be installed at each service connection and the water charges should be collected according to the meter reading. The existing meter repair shop should be completely equipped with necessary facilities for repairing work, and 40,000 meters both in stock and installed should be properly repaired.

Third, up-stream coffer dam as an initial step towards the completion of Simly Dam should be constructed as soon as possible and use it as reservoir temporarily before completion of Simly Dam by placing automatic gate at the entrance of diversion Tunnel. Moreover, small check dams for storage of water should be studied about its location near the existing head works and its feasibility.

2) First Stage Works (1971 - 1980)

To solve severe scarcity of water supply in Islamabad, it is the only way to complete the construction of Simly Dam as soon as possible and secure the water of 24 mgd in the drought season.

The duration of construction period is estimated to be three years and the cost is about US$25 million being composed of US$15 million (¥5,400 million) in foreign currency and US$10 million in local currency, on the basis of procurement of all the necessary equipments and machines. (Depending on the availability of some of the equipments and machines in Pakistan, the cost will be decreased accordingly.)

The second line of Simly Conduction Main should be constructed by 1976. Its construction cost is about US$3.5 million. Distribution pipes should be laid in accordance with the need of the increased population, and its cost is about US$2.7 million with escalation up to 1980.

3) Second Stage Works (1981 - 2000)

The proposed Khampur Filtration Plant with 45 mgd capacity and reservoirs should be constructed by 1982.

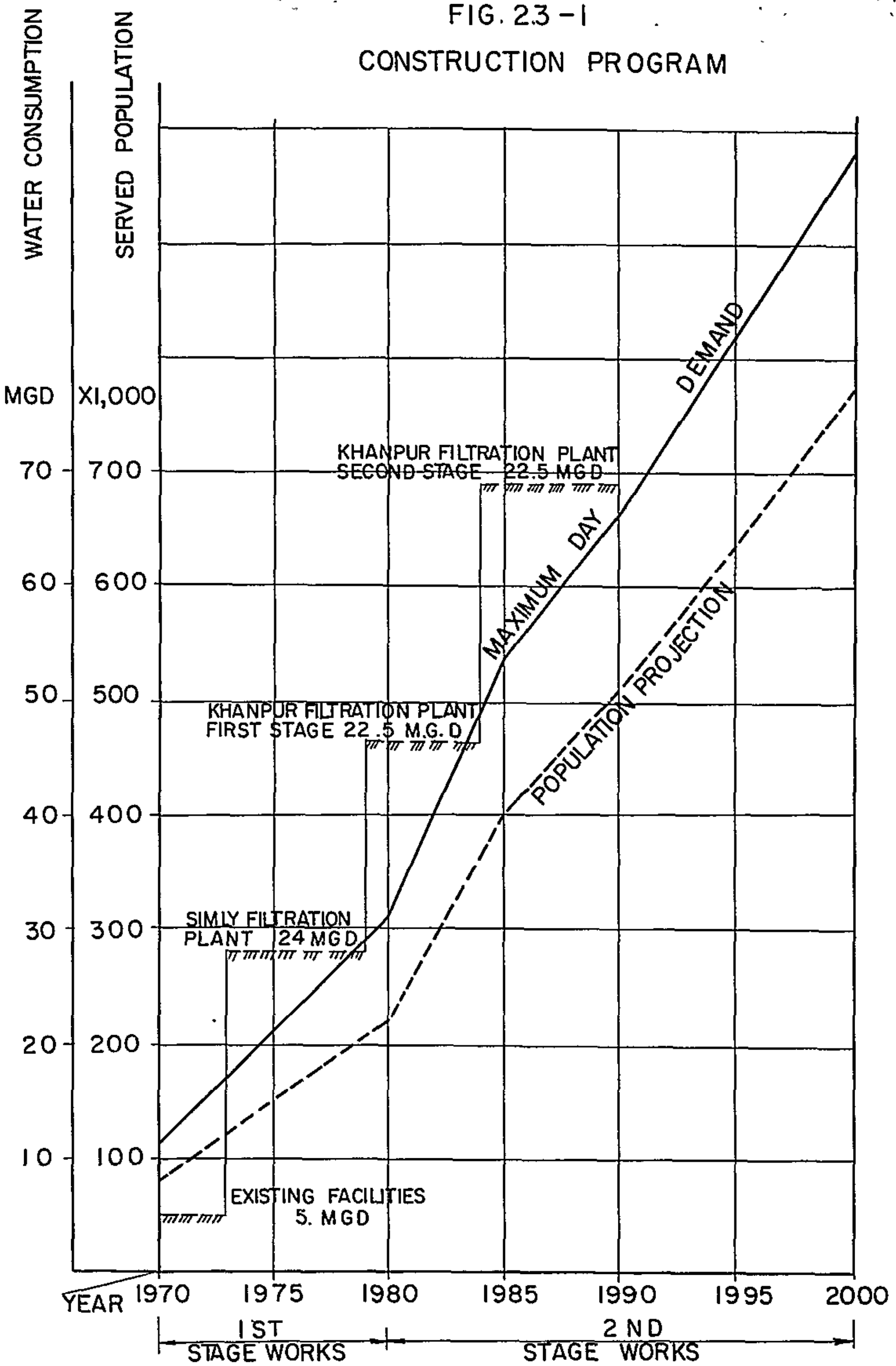
Distribution pipes should also be laid in accordance with the demand for the increased population.

4) Summary of Construction Cost

The summary of construction cost is given in Table 5.2-1. The components of foreign currency out of total construction costs on 1st stage works are shown in Table 5.2-2; and also the

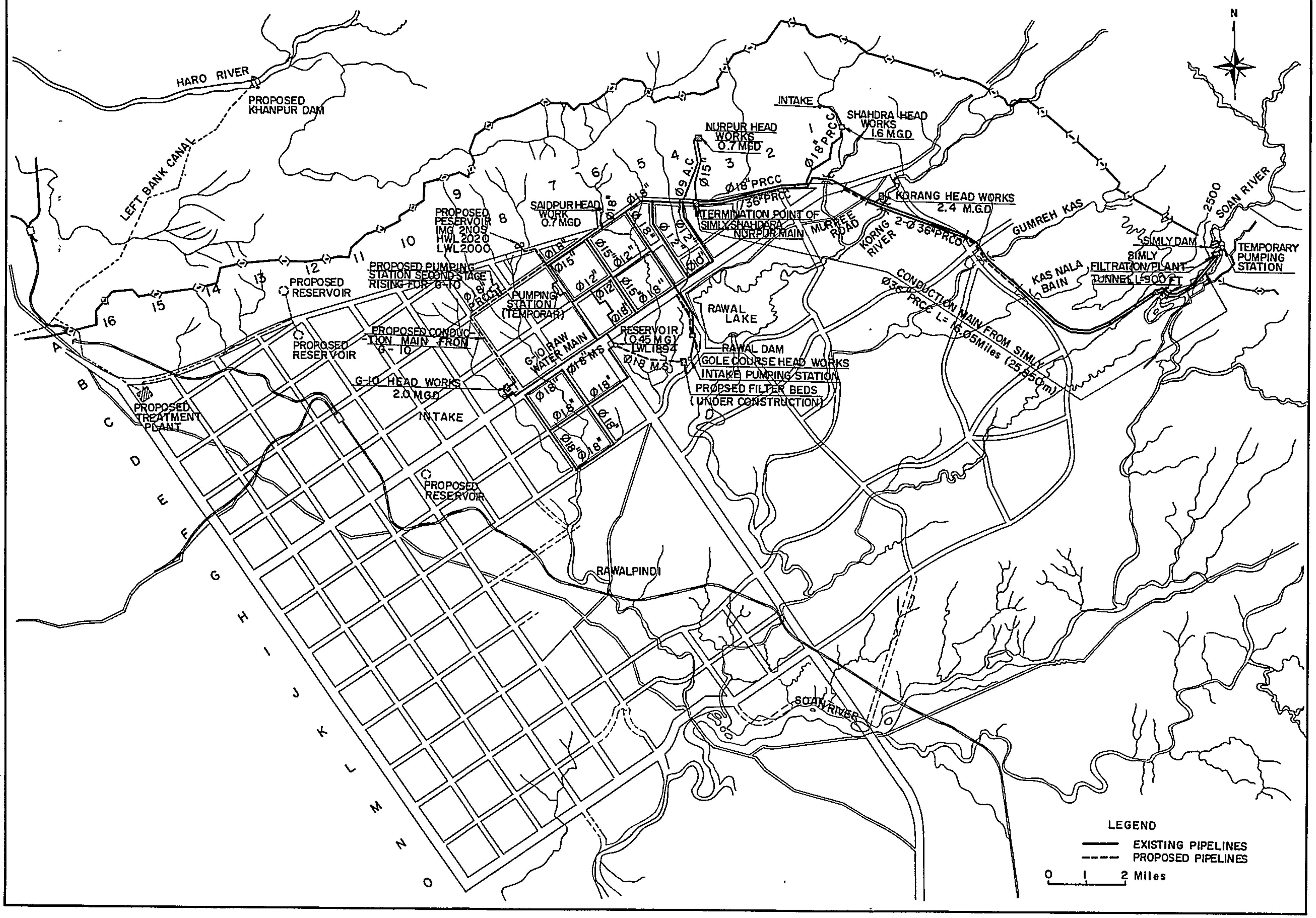
FIG. 2.3 -1

CONSTRUCTION PROGRAM




REHABILITATION WORKS

FIG 2.3-2 PLAN OF WATER WORKS FACILITIES IN ISLAMABAD



components of local currency out of total construction costs on 1st stage works are shown in Table 5.2-3. The total construction costs of 2nd stage works are indicated in Table 5.2-4.

### 2.3.2 Management

Careful review and strict evaluation regarding the efficiency of the existing organization for maintenance and operation of the water supply system have to be undertaken.

On the technical side of the management, emphasis has to be laid on development of programs on leakage control, waste prevention, and metering, with proper training on the personnel who will engage in these activities.

On the administrative and financial side of the management, system of meter reading, billing and collection of tariff has to be established, with training of personnel on simple methods of accounting and bookkeeping.

Since the metering system is the basis for sound management of the system, installation and rehabilitation of meters to all house connections have to be planned and executed, and, as mentioned earlier, the meter repair shop has to be equipped with necessary facilities in carrying out required repairing works.

Services of specialist/s on management may be secured from the Japanese Government by asking further assistance for a few months with terms of reference on review and assessment of existing organization and practice and on planning and recommendation for the future action.

### 2.3.3 Financial Arrangement

The Project as proposed requires considerable amount of funds, both in foreign and local currencies. It is therefore necessary to start planning for acquisition of funds required.

In accordance with the proposed work schedule, the loan schedule from a multilateral or/and bilateral sources has to be carefully considered.

Asian Development Bank (ADB), International Development Association (IDA, commonly called as the 2nd World Bank, providing softer loan than IBRD, the 1st World Bank), are the possible multilateral lending agencies to look for financial assistance. Among the bilateral sources, the Japanese Government indicated keen interest on the project and has already extended grant for the initial works required for the Project. It is possible that Japan would continue keeping interest on this Project and consider extending assistance both in the form of grant and loan in order to complete the project, in case the convincing plan for implementation of the Project and the reasonable approach for lending schedule is prepared.

# CHAPTER 3

# THE EXISTING WATER WORKS

# CHAPTER 3

# THE EXISTING WATER WORKS

## 3.1 WATER WORKS FACILITIES

### 3.1.1 General

At present, the Islamabad water works facilities consist of six head works, the Simly Filtration Plant and several tube-wells. These water supply facilities were built in the following calendar years.

| | | |
|---|---|---|
| 1 - Saidpur Head Works | ................... | 1963 |
| 2 - Nurpur Head Works | ................... | 1963 |
| 3 - Korang Head Works | ................... | 1966 |
| 4 - Golf Course Head Works | ................... | 1966 |
| 5 - Shahdra Head Works | ................... | 1967 |
| 6 - G-10 Head Works | ................... | 1970 |
| 7 - Simly Filtration Plant | ................... | 1965-7 |
| 8 - Tube-wells | ................... | 1962-3 |

In tune with the implementation of and as part of the Islamabad new city project started in 1960, both the Saidpur and Nurpur Head Works were completed and started to supply water to Islamabad in 1963 after the three years of construction period.

Planned and designed by Doxiades Associates of Athens taking charge of the Islamabad City master plan, these two head works were originally intended for supplying 1.4 mgd (maximum 6,300 $m^3$/day).

After the above two, three head works, Korang, Shahdra and Golf Course Head Works were successively constructed and completed in the year of 1967. These were planned and designed by CDA.

For the G-10 Head Works, the intake pumping station and transmission main were initially installed for the purpose of compensating for shortage of water required for the construction of new houses, buildings, etc. due to the progress of the city project. Currently, raw water taken from the water source is directed to the Saidpur Head Works, where it is treated collectively, and it is not complete with purification facilities. The Saidpur Head Works whose scale is identical with that of the Golf Course Head Works is constructed by CDA.

The Simly Filtration Plant was completed in 1965 by West German credit. But actual water supply operation was started in 1967 when the conduction main was installed.

Most of the tube-wells were installed in 1962-1963 to provisionally secure drinking water.

In addition to the facilities mentioned above, CDA is now expanding the Golf Course Head Works facilities with a view to case the recent 'chronic' shortage of water supply though it is considered not to bring about substantial result. Moreover, CDA is pushing forward a project of drilling additional tube-wells in the premises of the National Park, through which underground water from Rawal Lake is expected to be taken.

### 3.1.2 Water Sources and Water Supply System

#### a) Water Sources

Water sources to support the demand of water in the city of Islamabad are shown in Table 3.1-1. Viewed by types of sources, river surface water accounts for 80% of the total supply and ground water (including springs) accounts for the remaining 20%. All the water sources that have so far been developed have a total water intake capacity of 17.55 mgd (75,000 $m^3$/day). But the actual intake is reduced to about 1/3 of the normal capacity and this might mean that the flow condition of rivers is very unstable. This may chiefly be attributable to the following facts:

1) The annual rainfall in Islamabad district is about 37 inches (920 mm).

2) The rivers running through the Islamabad area, except Soan River, have a very limited catchment area. This results in small run-off flows of each river.

3) The foundation rock of this area is an aqueous rock composed of sandstone, shell, limestone, etc. Such ground structure formulates the mountains in the background of the drainage area, which have worn and been weathered to a great extent, with trees and bushes rarely growing. The results are a big run-off factor, less cultivated underground water and a small base flow.

4) Generally, the Islamabad ground configuration is hilly with less developed alluvium or diluvium which contributes to cultivation of underground water as is clear from foundation rock distributions. And the underground water there is less cultivated. For these reasons, the underground water level lies in a great depth and its volume is insufficient.

For the existing tube-wells in Islamabad, their casing depth is about 300 feet and the water level in tube-well is 70-80 feet. This result[illegible] a sharp draw-down while pumps are in operation, which in t[illegible] causes the pump operation per day to be limited to 4-5 hours [illegible]y.

From these studies, it is concluded that there will be no other way to develop water resources effectively than run-off control of

Table 3.1-1 Statement of Developed Water Sources of Water Supply in Islamabad

| S. No. | Particular | Location | Kind of Sources | Catchment Area at Intake (A) | Capacity of Intake (B) | Intake Facilities |
|---|---|---|---|---|---|---|
| 1 | Simly Filtration Plant | Simly | Surface water from Soan River | 150 $Km^2$ | MGD<br>5.0 (24) | Temporary intake pumps |
| 2 | Korang H/W | | Surface water from Korang River | | 2.4 | Shallow well and intake pumps |
| 3 | Shahdar H/W | | Surface water from stream | 0.15 | 1.6 | Concrete conduit |
| 4 | Nurpur H/W | Nurpur village | Surface water from stream | 0.03 | 0.7 | Collection well |
| 5 | Saidpur H/W | Saidpur village | Spring | 0.026 | 0.7 | Collection well |
| 6 | Golf Course H/W | Golf course in National Park | Surface water from stream | | 2.5 | Intake pumps |
| 7 | G-10 H/W | Sector G-10 | Surface water from stream | 0.74 | 2.0 | Intake pumps |
| 8 | Tube-wells | Sector G-7<br>Sector G-9, I-9 | Under ground water | | 2.65 | Intake pumps |
| | Total | | | | MGD<br>17.55 | |

Table 3.1-2 Statement of Water Supply System from Each Water Sources in Islamabad

| S. No. | Water Sources | Plant Capacity in MGD | Water Treatment | Water Dupply System: Intake | Water Dupply System: Transmission to Reservoir | Water Dupply System: Distribution |
|---|---|---|---|---|---|---|
| 1 | Simly F/P | 5.0 MGD | Rapid sand filtration chlorination | Temporary pump up | Dravity flow | Gravity flow |
| 2 | Korang H/W | 2.4 | Slow sand filtration, chlorination | Pump up | | Pump up |
| 3 | Shahdra H/W | 1.6 | " | Gravity flow | Gravity flow | Gravity flow |
| 4 | Norpur H/W | 0.7 | " | Gravity flow | | Gravity flow |
| 5 | Saidpur H/W | 0.7 | " | Gravity flow | | Gravity flow |
| 6 | Golf Course H/W | 2.5 | " | Pump up | | Pump up |
| 7 | G-10 H/W | 2.0 | " | Pump up | Pump up | Gravity flow |
| 8 | Tube-wells | 2.65 | Chlorination | Pump up | (1) Pump<br>(2) Gravity flow from over head thanks | |
| | Total | 17.55 | | | | |

rivers. In other words, the most urgent need will be to construct an effective dam for water supply or a multi-purpose dam permitting fair distribution of water resources on a river having a large annual run-off, such as Soan River or Khanpur River.

The completion of Simly Dam is earnestly desired at as early a date as possible. It is believed that tubewells currently planned and drilled by CDA in the area of the National Park and the extension of plant in Golf Course are nothing but provisional means and will not be a perpetual solution to eliminate the present chronic water shortage problems to supply the city with sufficient water.

b) Water Supply System

Figs. 3.1-1 and 3.1-2 show the relative positions and distribution systems of such water works facilities as head works, filtration plant, conduction main and distribution pipe line.

An outline of the water supply system in Islamabad is summarized in Table 3.1-2. As shown, water is supplied from the Simly Filtration Plant and six head works to sectors F-6, F-7, G-6, G-7, etc. where distribution pipes are provided completely.

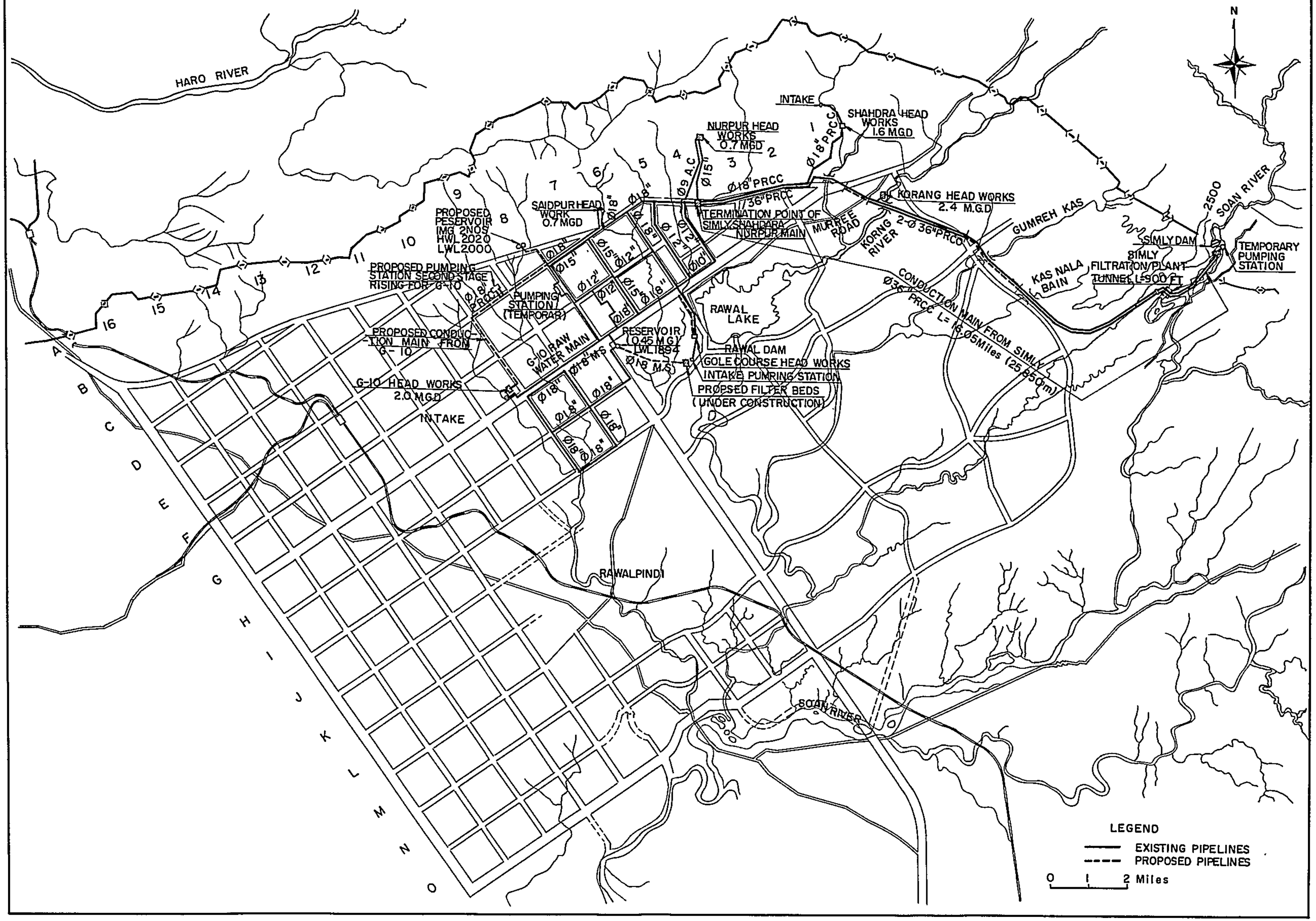
In the case of the G-10 Head Works, no treatment plant has been installed and raw water is led to Saidpur Head Works for treatment.

Since the area served by these water sources is limited to sectors east of F-7 and G-7, the existing and CDA proposed reservoirs are concentrated in sectors F-7, F-6 and G-5. When the service area is extended to the western areas, there will be a problem regarding the proper relative positions between the reservoirs and the service area to be covered by them.

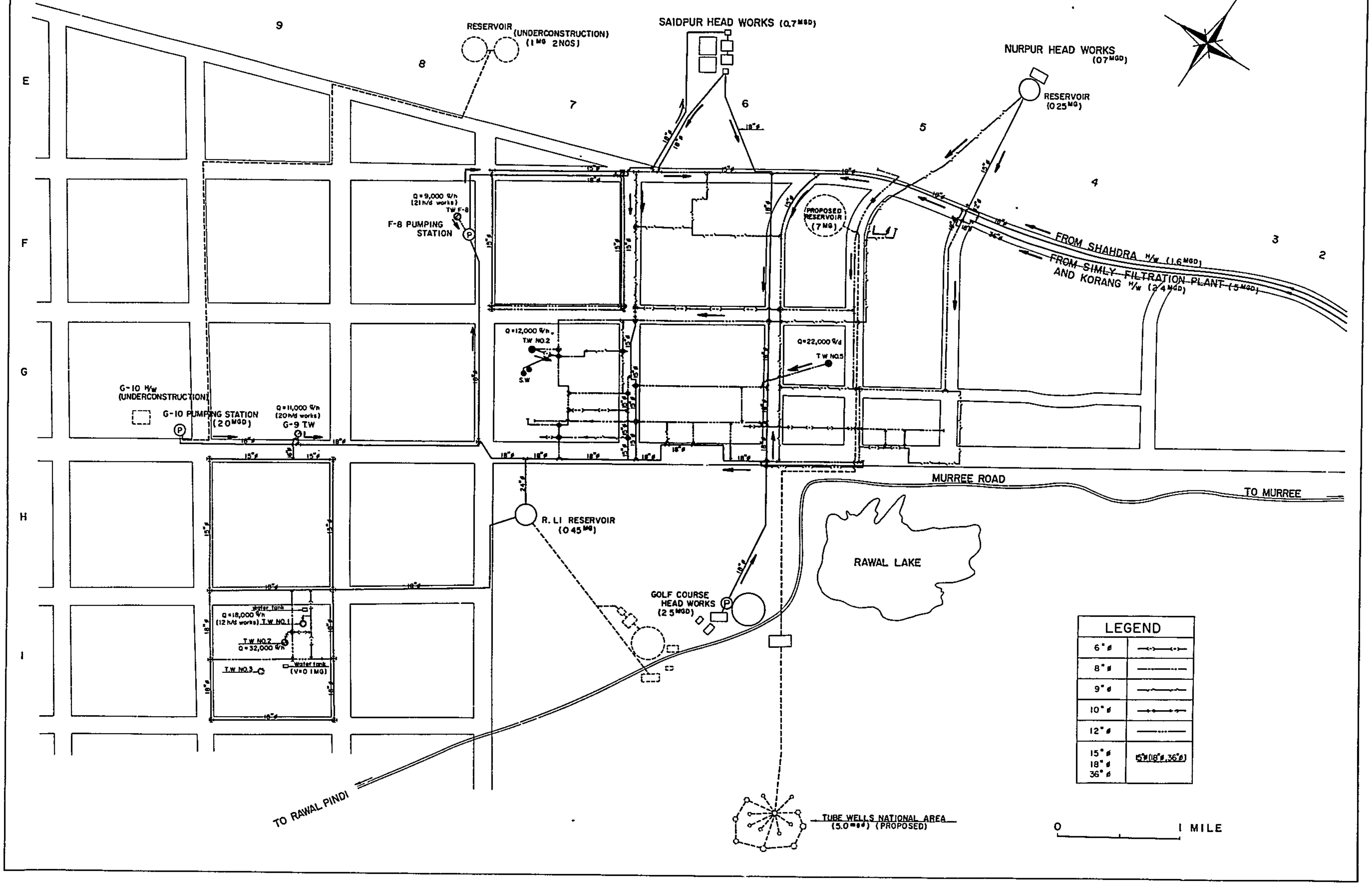
CDA is now pushing forward a plan to construct a reservoir of clean water conducted from Simly Filtration Plant, Korang and Nurpur Head Works in sector F-5. But it is expected that, when Simly Dam is completed and water is supplied at the rate of 24 mgd, the service area to be covered by this water system will largely be the western sectors, judging from the present and future population distribution estimated on the basis of the new city project. If this is taken into consideration, reconsideration will become necessary on the capacity, location, altitude, etc. of the reservoir currently proposed.

In sector I-9, water is supplied through the tubewells located within the sector and their overhead tanks. The water main pipe of 18 inches diameter is connected to this sector from the reservoir located on Shackarparian Hill near the view point of Islamabad.

FIG 3.1-1 PLAN OF EXISTING WATER WORKS FACILITIES IN ISLAMABAD



# FIG3.1-2 EXISTING DISTRIBUTION SYSTEM IN ISLAMABAD



### 3.1.3 Water Quality

a) Raw Water Quality

Table 3.1-3 shows typical water quality test data of each source quoted and summarized from test records kept at the laboratory of Simly Filtration Plant and National Health Laboratory of the Pakistan Government, Islamabad.

Especially noteworthy of the raw water quality listed in Table 3.1-3 is that each of them quoted has higher values than normal in pH, total solids, hardness and alkalinity. pH values range from 8.4 to 7.5 with an average of more than 8.0 except for Korang Head Works (7.5). The total solids are 279 ppm maximum with an average of 250 ppm, while the alkalinity is 292 ppm with an average of 200-300 ppm. To sum up, these water sources are highly alkaline.

Such high alkalinity of the water is considered to be caused by the geological conditions as mentioned in paragraph 3.1.2. In the mountains behind the city are limestone strata, from which alkaline contents are supplied, directly and indirectly, to the rivers originating from these mountains, resulting in the above-mentioned water quality.

However, water at Simly Filtration Plant has a very low alkalinity compared with other sources. Normally, D-alkalinity is found where the pH value exceeds 8.3. Values of Golf Course Head Works, for example, are the typical case in that alkalinity of 183 ppm exists compared with pH of 8.3. In the case of Simly Filtration Plant, the data given to us shows alkalinity of 18.65 ppm compared with 8.3 pH value. This is suspicious but since test data of hardness, total solids, etc. that will be helpful in making judgment on the alkalinity content are not available, this problem cannot be clarified. However, it is highly probable that the alkalinity of water at Simly Filtration Plant is actually higher than 18.65 ppm compared with that of Korang River the situation of which is very similar to that of Soan River.

So long as the data given in Table 3.1-3 are concerned, there is found nothing to prove the existence of harmful contamination sources since the contents of ammonia, nitrite, nitrate nitrogen, chloride, sulphate, etc. in raw water are lower than the WHO standard for drinking water.

On the basis of the information described above, the following items are required to be considered for the treatment of water;

1) In the course of sedimentation, large amount of alum should probably be dosed in raw water for effective floc formation and settling.

2) Since values of total solids, hardness, alkalinity, etc.

are higher than normal but fall in the WHO standard for drinking water, it will not be necessary to provide special treatment for reducing or eliminating them. Particularly, alkaline water is corrosion resistant and is therefore good for water works facilities such as distribution pipes while it may be slightly inferior in taste.

3) Sedimentation, filtration (with rapid sand filter or slow sand filter) and chlorination will permit these water supplies to provide potable water. In case the raw water is to be introduced from Simly Dam, it may be necessary to add chlorine, copper chloride, etc. to the raw water as pre-treatment to remove micro-organisms which may grow in the reservoir.

b) Treated Water in Simly Filtration Plant

Records of analysis of water quality after treatment have been obtained from Simly Filtration Plant, as shown in Table 3.1-4. This table represents monthly mean values arranged from daily records kept for the ten months from July 1969 to April 1970. However, these test data are not enough for making correct judgment on the total solids, hardness, most probable number of coliforms, etc., but the followings are general impressions gathered from the data on the quality of treated water at Simly Filtration Plant.

1) The water temperature at the Filtration Plant is 28°C maximum with an average of 25°C in the summer season from April to September. It is greatly influenced by high atmospheric temperatures. High water temperature will be advantageous for flocculation but will cause a density flow to be likely to occur in the settling basin, resulting in a carry-over phenomenon.

2) From the data given in Table 3.1-4, the treated water has normal turbidity, odor, color, etc. Therefore, it is assumed that purification works at Simly Filtration Plant are carried out smoothly and satisfactorily.

3) The pH value ranges from 7.1 to 7.6, which is in the normal range. But a comparison of these values with those of raw water indicates a high decrease in pH. This shows that oxidizer, such as alum, has been dosed in the raw water in a considerably great quantity. Checking how treated water was sampled, it has been revealed that the sampling was made immediately after chlorination -- the time when pH value is normally low. Thus it is believed that the pH value will rise again when the water has reached the service area because of the consumption of chlorine dosed at the filtration plant.

Table 3.1-3 Statement on Untreated Water (Raw Water) Qualities of Various Water Sources in Islamabad

| Sample Sources | Filtration Plant and Head Works | | | | | | | Tube-Wells | | Other Sources | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Simly | Korang | Shahadara | Nurpur | Saidpur | Golf Course | G-10 | TW NO2/G7 | TW NO1/I-9 | Rawal Lake | Indus River |
| Date of Examination | 11-3-70 | 3-2-69 | 22-1-69 | | 18-3-70 | 17-3-70 | 21-3-70 | 25-1-70 | | 17-3-70 | 24-3-70 |
| Temperature | 15°C | - | - | - | - | - | - | - | - | - | 24°C |
| Appearance | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Dirty brown | Clear |
| Colour | | | | | | | | | | | |
| Odour | | | | | | | | | | | |
| Taste | | | | | | | | | | | |
| pH Value | 8.9 | 7.5 | 8.0 | 7.9 | 8.0 | 8.3 | 7.9 | 8.0 | 8.2 | 8.0 | 8.3 |
| Total Solids | - | 170 | 275 | 237 | 178 | 208 | 258 | 270 | 279 | 443 | - |
| Free and Saline Ammonia Nitrogen | Nil | 0.028 | 0.016 | 0.02 | 0.02 | 0.048 | 0.04 | 0.016 | 0.012 | 0.04 | |
| Albuminoid Ammonia Nitrogen | Nil | 0.04 | 0.024 | 0.03 | 0.02 | 0.06 | 0.052 | 0.024 | 0.024 | 0.064 | " |
| Nitrite Nitrogen | Nil | Nil | - | Nil | Nil | 0.01 | Nil | Nil | Nil | 0.001 | " |
| Nitrate Nitrogen | Nil | 0.25 | 0.3 | 0.20 | 0.25 | 0.3 | 0.23 | 0.2 | 0.3 | 0.26 | " |
| Oxygen Demand | - | 0.04 | 0.12 | 0.08 | 0.12 | 0.12 | 0.08 | 0.08 | 0.04 | 0.112 | - |
| Chloride | 16.5 | 6 | 6 | 5.5 | 6 | 10 | 9 | 8.5 | 8.5 | 6.5 | 21 |
| Sulphate | - | 19.2 | 24 | 28.8 | 24 | 28.8 | 23 | 24 | 24 | 24 | - |
| Total Hardness | - | 145 | 30.3 | 256 | 315 | 198 | 205 | 293 | 318 | 131 | - |
| Temporary | - | 54 | 190 | 118 | 195 | 152 | 121 | 188 | 193 | 58 | - |
| Permanent | - | 91 | 113 | 138 | 120 | 46 | 84 | 105 | 125 | 73 | |
| Alkalinity as Ca Co. | 18.65 | 122 | 286 | 232 | 292 | 183 | 176 | 262 | 277 | 118 | 6.89 |
| Iron | - | Nil | Nil | Nil | Nil | Nil | Nil | 0.01 | Nil | Nil | Nil |
| Manganese | - | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| Residual Chlorine | - | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |

Table 3.1-4 Monthly Variation in Treated Water Quality at Simly Filtration Plant

| Monthly | 69 JULY | AUGUST | SEP. | OCT. | NOV. | DEC. | 70 JAN. | FEB. | MAR. | APR. | Annual | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | 28°C | 26°C | 25°C | 22°C | 17°C | 13°C | 10°C | 12°C | 13°C | | 18°C | |
| Appearance | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | | |
| Turbidity | 0.53 | 0.50 | 0.56 | 0.55 | 0.57 | 0.43 | 0.44 | 0.43 | 0.47 | 0.4 | 0.5 | |
| Odour | OL | " | " | " | " | " | " | " | " | " | - | |
| Taste | UO | " | " | " | " | " | " | " | " | " | - | |
| Colour | UO | " | " | " | " | " | " | " | " | " | - | |
| Residue Dried at 120°C | - | - | - | - | - | - | - | - | - | - | - | |
| pH Value | 7.1 | 7.5 | 7.3 | 7.6 | 7.6 | 7.7 | 7.7 | 7.7 | 7.7 | 7.6 | 7.6 | |
| Alkalinity as $CaCO_3$ | 6.7 | 6.7 | 6.2 | 7.1 | 7.2 | 8.6 | 8.9 | 9.4 | 9.2 | 7.8 | 7.8 | |
| Chloride as Cℓ | - | - | - | 13 | 13 | 12 | 11 | 12 | - | (12) | (12) | |
| Oxygen Demand | - | - | - | - | - | - | - | - | - | - | - | |
| Hardness as $CaCO_3$ | - | - | - | - | - | - | - | - | - | - | - | |
| Ammonia (Free) | Absent | " | " | " | " | " | " | " | " | " | - | |
| Nitrogen (Nitrite) | Absent | " | " | " | " | " | " | " | " | " | - | |
| Iron | - | | | | | | | | | | | |
| Residual Chlorine | 0.31 | 0.85 | 1.6 | 1.7 | 1.5 | 1.8 | 1.7 | 0.9 | 0.7 | | 1.2 | |

Table 3.1 – 5 Water Quality Standards for Drinking Water

| Substance | WHO | JAPAN | USA | WHO for EUROPE |
|---|---|---|---|---|
| Coliform groups | less than MPN 10 | never detected in 50 ml | positive samples: less than 10% in a month | less than 15 samples in 100 samples (100 ml) |
| Number of bacteria | — | less than 100 in 1 ml. | — | — |
| Odour | — | unobjectionable | $3^{o}$ | — |
| Taste | | " | unobjectionable | |
| Colour | | $5^{o}$ | $12^{o}$ | — |
| Turbidity | — | $2^{o}$ | $5^{o}$ | — |
| Total solids | — | 500 | 500 (1000) | — |
| pH range | 7.0 – 8.5 unit (6.5 – 9.2) | 5.8 – 8.6 unit | | |
| Total Hardness | 100 – 500 * | 300 * | | 100 – 500 |
| $KMnO_4$ consumed | 10 | 10 | 250 | |
| Chloride | 200 (400) | 200 | | 350 |
| Sulphate | 200 (400) | — | 250 | 250 |
| Ammonia Nitrogen | 0.5 | never detected at the same time | — | 0.5 |
| Nitrite Nitrogen | — | | — | — |
| Nitrate Nitrogen | 40 (80) ** | 10 | 45 * | 5.0 |
| Iron | 0.3 (1.0) | 0.3 | 0.3 | 0.1 |
| Manganese | 0.1 (0.5) | 0.3 | 0.05 | 0.1 |
| Fluorine | 1.0 (1.5) | 0.8 | 0.6 – 1.7 | 1.5 |
| Lead | 0.1 | 0.1 | 0.05 | 0.1 |
| Arsenic | 0.2 | 0.05 | 0.01 (0.05) | 0.2 |
| Selenium | 0.05 | — | 0.01 | 0.05 |
| Chromium | 0.05 | 0.05 | 0.05 ** | 0.05 |
| Copper | 1.0 | 1.0 | 1.0 | 0.05 |
| Zinc | 5.0 (15.0) | 1.0 | 5.0 | 5.0 |
| Phenols | 0.001 (0.002) | 0.005 | 0.001 | 0.001 |
| Cyanid | 0.01 | never detected | 0.1 (0.2) | 0.001 |
| Mercury | — | | 0.05 | — |
| Barium | — | — | 1.0 | — |
| Cadmium | — | — | 0.01 | 0.005 |
| ABS | — | — | 0.5 | — |
| Radioactivity | α – ray 1 μμc/l<br>β – ray 10 μμc/l | | $Ra^{226}$, 3 μμc/l a year<br>$Sr^{90}$, 10 μμc/l "<br>gross β, 100 μμc/l " | α – ray 1 μμc/l<br>β – ray 10 μμc/l |
| Organic phosphate | — | never detected | — | — |
| Free residual chlorin | — | less than 0.1 | 0.05 – 0.1 | — |
| Magnesium | 50 (150) | — | — | — |
| Calcium | 75 (200) | — | — | — |
| Remarks | ( ): Max. allowable<br>* as $CaCO_3$<br>** as $NO_3$<br>no indication number<br>unit : ppm | * as $CaCO_3$ | * $NO_3$<br>** Sexivalent Cr<br>( ): Max. allowable | |

Table 3.1-6 Tap Water Quality for Each Sector in Islamabad

| Sample Sources | Secreta-riate Block | Govt. Hostel | Sector F-6/1 | Sector F-6/3 | Sector F-6/4 | Sector G-6/1 | Sector G-6/2 | Sector G-6/3 | Sector G-6/4 | Sector G-7/3 | Sector G-7/3 | Average in Table | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date of Examination | 22-1-70 | 29-12-70 | 22-2-69 | 7-5-69 | | 6-5-69 | 4-1-69 | 7-2-69 | 2-4-69 | 7-5-69 | 17-7-69 | | |
| Temperature | | - | - | - | - | - | - | - | - | - | - | - | |
| Appearance | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | - | |
| Colour | | | | | | | | | | | | | |
| Odour | | | | | | | | | | | | | |
| Taste | | | | | | | | | | | | | |
| pH Value | 7.9 | 8.0 | 7.9 | 8.1 | 8.0 | 8.4 | 8.1 | 7.9 | 8.1 | 8.1 | 7.9 | 8.0 | |
| Total Solids | 268 | 268 | 230 | 189 | 224 | 224 | 266 | 190 | 293 | 196 | 238 | 235 | |
| Ammonia Nitrogen | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | 0.02 | Nil | 0.024 | - | |
| Albuminoid Nitrogen | " | " | " | " | " | " | " | " | 0.032 | " | 0.036 | - | |
| Nitrite Nitrogen | " | " | " | " | " | " | " | " | Nil | " | Nil | - | |
| Nitrate Nitrogen | 0.23 | 0.24 | 0.25 | 0.3 | 0.25 | 0.2 | 0.3 | 0.2 | 0.25 | 0.25 | 0.23 | 0.24 | |
| Oxygen Demand | 0.08 | 0.08 | 0.04 | 0.04 | 0.08 | 0.08 | 0.04 | 0.08 | 0.08 | 0.04 | 0.12 | 0.07 | |
| Chloride | 9 | 9 | 8 | 8 | 7 | 10 | 7 | 7.5 | 9 | 8 | 8 | 8.2 | |
| Sulphate | 268 | 24 | 24 | 19.2 | 19.2 | 28.8 | 34.5 | 24 | 24 | 21.1 | 24 | 24 | |
| Total Hardness | 244 | 210 | 244 | 160 | 206 | 209 | 302 | 176 | 223 | 164 | 220 | 214 | |
| Temporary | 135 | 107 | 120 | 75 | 71 | 114 | 180 | 69 | 111 | 84 | 113 | 108 | |
| Parmanent | 109 | 103 | 124 | 85 | 134 | 95 | 122 | 98 | 112 | 80 | 107 | 106 | |
| Alkalinity as $CaCO_3$ | 212 | 187 | 216 | 127 | 172 | 173 | 274 | 115 | 202 | 131 | 172 | 180 | |
| Iron | Nil | Nil | 0.01 | 0.01 | Nil | Nil | 0.01 | Nil | Nil | Nil | Nil | - | |
| Manganese | " | " | Nil | Nil | " | " | Nil | " | " | " | " | | |
| Residual Chlorine | 0.1 | 0.1 | 0.4 | 1.0 | 0.1 | 0.6 | 0.6 | 0.4 | " | 0.5 | Nil | 0.2 | |

4) The alkalinity of the treated water is in the range of 6.0-9.0 ppm, with an average value of 7.8 ppm. As suggested in the foregoing paragraph (3.1.3 a) Raw Water Quality), problem remains in the fact that these values are unreasonably low compared with those at other head works.

5) The residual chlorine is 1.8 ppm at the maximum and 1.2 ppm in the average. Simly Filtration Plant is about 16 miles (28 km) away from its service area and chlorine may be consumed while running through the transmission line. For this reason, it may be necessary to increase the dosage of chlorine so that the residual chlorine may be maintained at 2 ppm or more in the plant.

c) Tap Water in Service Area

Table 3.1-6 represents the quality of water at the taps located in the service area, quoted and arranged from Records of Water Quality Testing for Water Taps run by the National Health Laboratory. The general impressions on tap water quality based on these quality testing results are described below:

1) No special discussion will be needed for the appearance, color, odor, taste, etc. However there appears a difference in the testing data among those who are engaged in testing.

2) The pH value of the tap water in the service area ranges from 8.4 to 7.9, with an average of 8.0. This may be slightly higher than normal. The WHO Standard for Drinking Water specifies normal pH value range of 8.5-7.0, with the range of 6.5-9.2 for the worst case only. The pH values of the tap water in question fall in the standard specified and so there will be no problem on this subject.

3) With respect to hardness and alkalinity, the values of the tap water seem higher than in ordinary cases, but there is found little difference in alkalinity between the raw water and treated water at the tap. This clearly indicates shortage in the dosage of oxidizer such as alum and chlorine when the water is treated, having not reduced the alkaline content to an appropriate level. However, as the values shown in Table 3.1-6 are all in the standard range set forth by WHO, it may be unnecessary to take special considerations in removal of hardness.

4) When water quality is discussed extensively for raw water, treated water and tap water, it is found that values of alkalinity and hardness are rather high, resulting in a proportionate increase in total solids. But since substances or impurities, such as iron, manganese, nitrogen, etc. are not detected at all or are detected in very insignificant quantities, it is concluded that the water sources are generally good with little contamination.

### 3.1.4. Filtration Plant and Head Works

a) Simly Filtration Plant

Simply Filtration Plant is situated about 13 miles (20 km) east of Islamabad and is a treatment plant that has the largest capacity and up-to-date facilities in Islamabad.

The plant has maximum capacity of 24 mgd (116,000 $m^3$/day), with treatment facilities for sedimentation, rapid sand filtration and chlorination as shown in Figs. 3.1-3 and 3.1-4.

According to the initial plan of this plant, raw water was to be taken from a dam reservoir at Simly. But this dam has not yet been completed and surface water on Soan River is taken from the temporary pumping station installed adjacent to Soan River and introduced directly to the plant.

The sedimentation facility consists of four circular sedimentation basins. Each basin is composed of the central chemical mixing and flocculation tank and the outer settling tank.

For coagulation, alum is dosed in the central tank and flocs are formed with four flocculators. The detention time for flocculation is 20 minutes, while that of the settling tank is 3 hours. Supernatant water in the settling tank flows into the flume located around the tank wall and then is distributed to each filter basin.

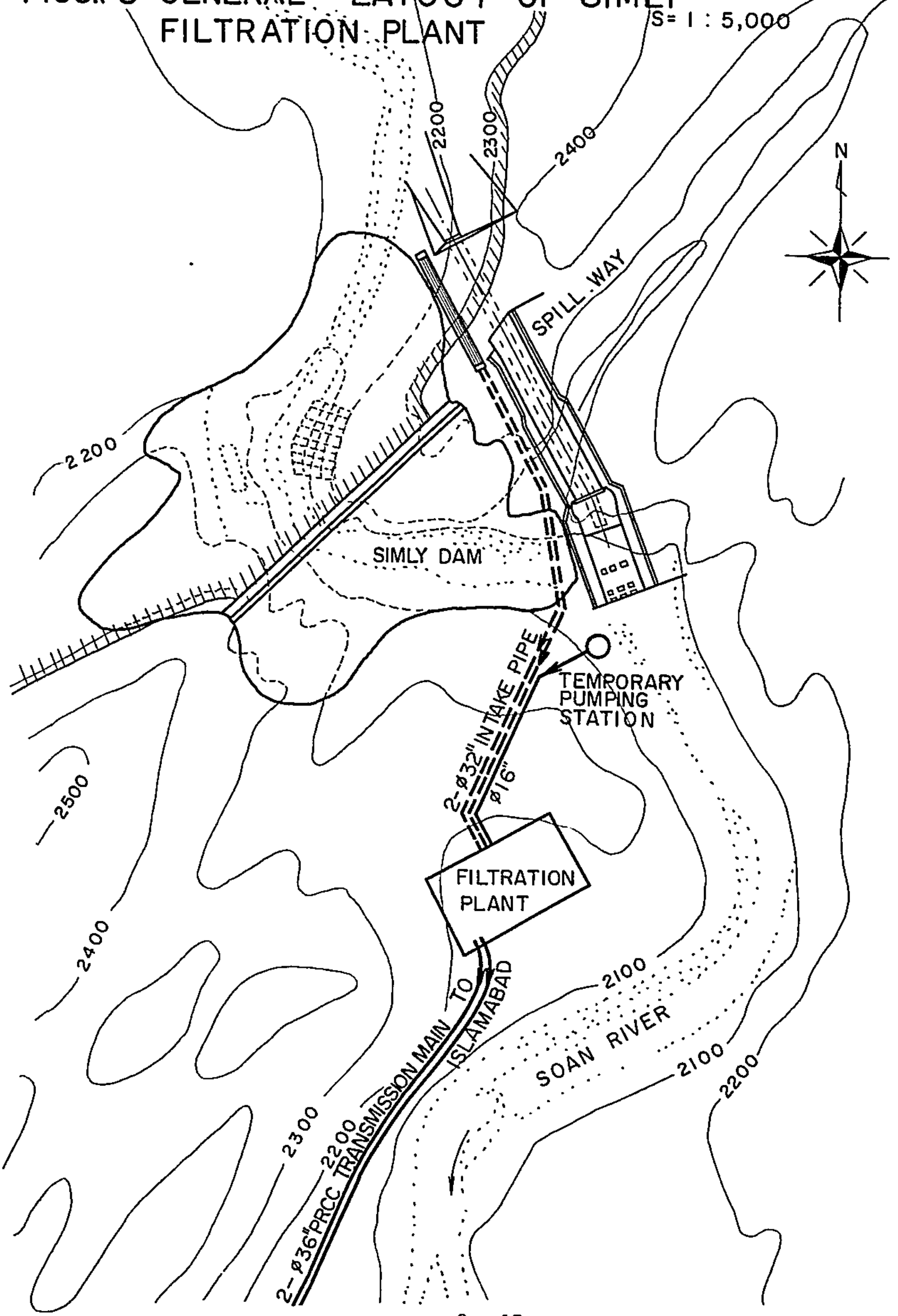
Water is filtered by the gravity system. The filter consists of total 12 basins and each basin has four blocks, each being composed of 3 basins as a unit. The rate of filtration is 1.7 gpm/sq.ft (120 m/day) average and 2.5 gpm/sq.ft (180 m/day) maximum. Water and air are used for backwashing of filter beds and no surface washing facilities are provided. Filtered water is stored in the clean water reservoir at the bottom of each filter basin, where the water is subject to chlorination. Then it is delivered by gravity into transmission mains.

The treatment plant is equipped with instrumentation equipments. Water levels in the main facilities, and flow discharges of raw water, filtered water, discharge water, etc. are indicated on the central control/monitor panel installed in the operation center. These data are automatically recorded there. Intake pumps and other drive equipments are operated by remote control from the operation center.

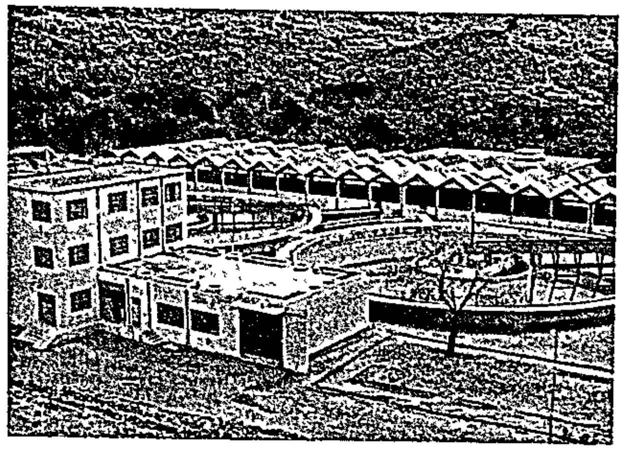
So as to be able to keep on a supply of electricity for the most important drives in the event of power failure, an emergency power supply unit having a capacity of 300 KVA is installed in the engine room.

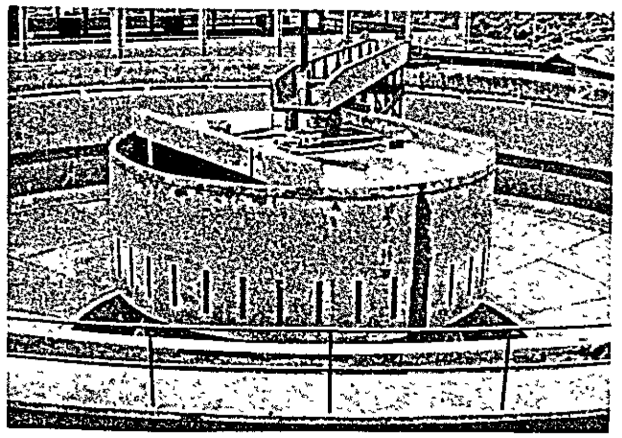
A laboratory is provided in the operating building for the purpose of monitoring and controlling water treatment processes at the treatment plant, thereby producing safe, clean water at all times. In this laboratory, raw water and treated water are analyzed and their data are registered.

FIG3.1-3 GENERAL LAYOUT OF SIMLY FILTRATION PLANT

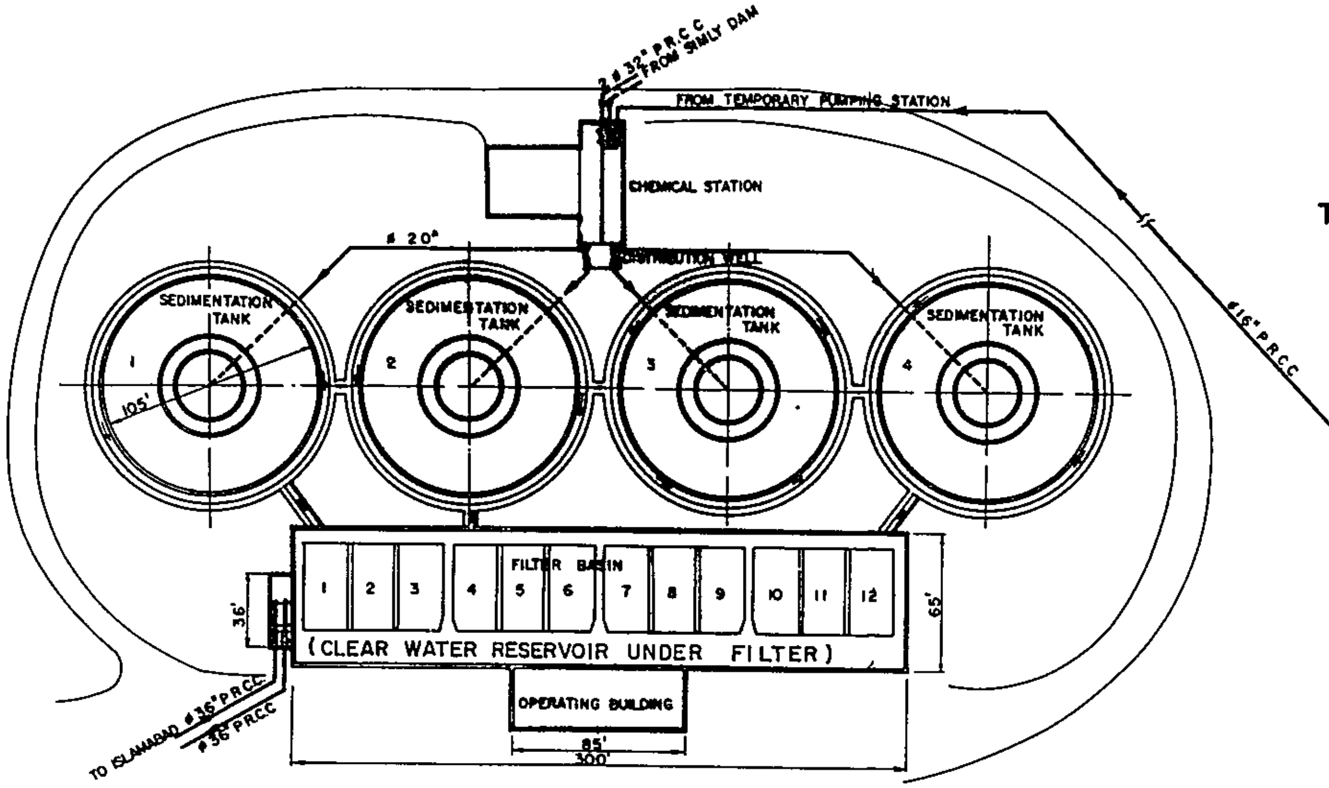


## FIG 3.1-4 SIMLY FILTRATION PLANT



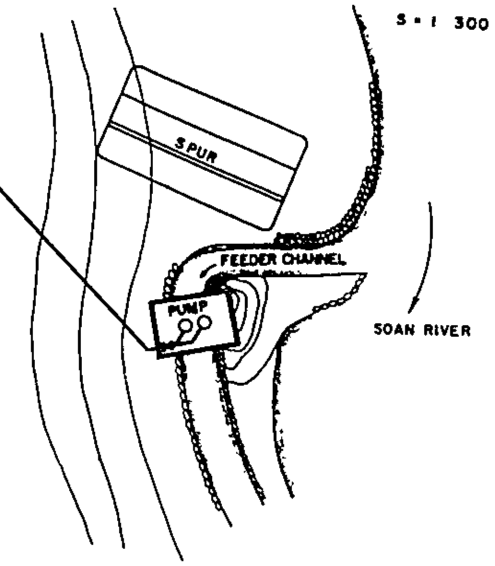


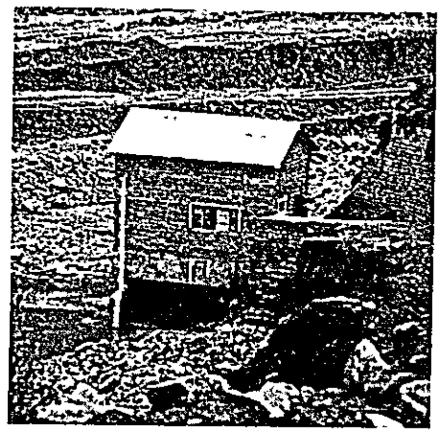
S = 1:500




### TEMPORARY PUMPING STATION

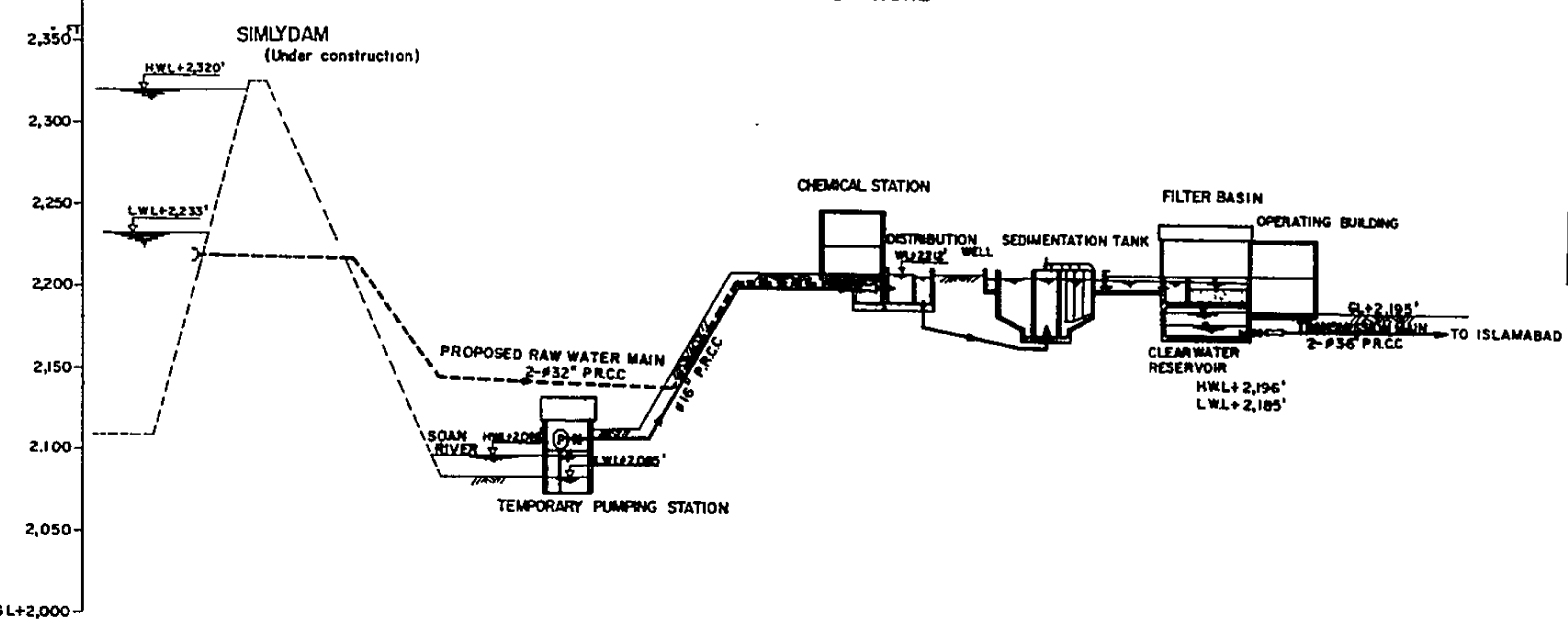
S = 1 300



## FLOW DIAGRAM

S = NONE



Major facilities in Simly Filtration Plant are as follows:

| | |
|---|---|
| Temporary Intake Pumping Station | |
| Pump house | |
| Intake pumps | 2 Nos. |
| Vertical type electrically-driven KSB pump | |
| Unit capacity | 1,670 gpm (456 $m^3/h$) |
| Motor output | 125 HP |
| Distribution Well | 1 No. |
| Sedimentation Basin | 4 Nos. |
| Capacity | 6 mgd (1,140 $m^3/h$) |
| Flocculation chamber | 81,400 gallons (380 $m^3$) |
| Settling chamber | 750,000 gallons (3,400 $m^3$) |
| Effective total volume | 830,000 gallons (3,770 $m^3$) |
| Flocculation time | 20 minutes |
| Settling time | 3 hours |
| Filter | 12 Nos. |
| Capacity | 2 mgd (380 $m^3/h$) |
| Filter bed area | 824 sq. feet (76.56 $m^2$) |
| Filtration rate | |
| Average | 1.7 gpm/sq. ft (120 m/d) |
| Maximum | 2.5 gpm/sq. ft (175.2 m/d) |
| Clear Water Reservoir | 2 Nos. |
| Effective volume | 400,000 gallon (1,800 $m^3$) |

Chemical Station

Coagulant feeding facilities

Chlorine feeding facilities to raw water and filtered water

Station house

Operating Building

| | |
|---|---|
| On 1st floor ........... | Central operating room,<br>Laboratory,<br>Main Office |
| On ground floor ......... | Pipe gallery of filtration plant<br><br>Engine room for emergency power unit |

Operating conditions of Simly Filtration Plant are summarized below:

1) Intake quantity from Soan River is 5.0 - 3.0 mgd according to the records. When Simly Dam is completed, raw water of 24 mgd at a maximum can be secured for full operation of the plant. At present, the quantity of raw water treated is less than 1/4 of the design capacity.

2) In sedimentation, the average dosage of alum is estimated to be 40-50 ppm. In actual flocculation, however, effective and good flocs were not formed at the time of survey. This may be attributable to the quality of raw water having high alkalinity, as mentioned in paragraph 3.1.3.

3) According to the past records, backwashing of rapid sand filters is conducted once a week, which is too infrequent. Normally, the running time of filters is 40 hours at the longest even if good sedimentation is provided. Continuous filtering operation without backwashing of filters will cause rapid clogging of filter and reduced filtration capacity.

   Since the operating efficiency of the plant is about 20% of the total capacity, it may be possible to extend the running time of filters slightly longer than in ordinary cases but it is desirable to improve the filtration cycle.

4) Examination of water quality is done in the laboratory of this Plant. However, as referred to in paragraph 3.1.3, the examination does not cover full details with the result

that no distinctive water analysis has been available.

For this reason, it is necessary to have the laboratory equipped more completely so that safer and more reliable water will be produced.

b) Korang Head Works

Korang Head Works is located about 6.0 miles east of Islamabad and near Korang River. Its design capacity is 2.4 mgd (11,600 $m^3$/day).

Flow diagram of the plant is shown in Fig. 3.1-5.

For the intake operation of the plant, water is introduced from Korang River to the pump suction well, and then is pumped into the sedimentation basin at the treatment plant.

One sedimentation basin of circular type is installed and consists of the central coagulation tank and the outer settling tank. Sedimentation time is about one hour for capacity of 2.5 mgd. For coagulation purpose, alum is dosed in raw water. Chemical mixing and agitation are conducted by using the residual water head of raw water flowing into the sedimentation basin.

Six slow sand filters are used for filtration, with an average rate of filtration of 10.8 m/day. Filtered water is temporarily stored in the pumping suction well where it is subject to chlorination. Then the water is suctioned up with main pumps and directed to service areas through the conduction mains from Simly.

Main facilities in Korang Head Works are as follows:

Intake Facilities

Pumping suction well with collecting gallery and intake pipes (ø15'-6" diameter)

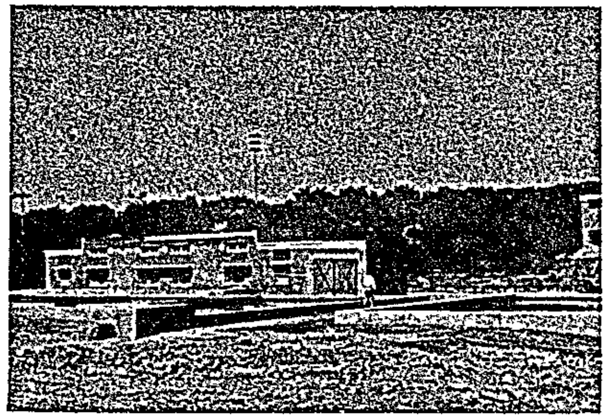
Intake pumps

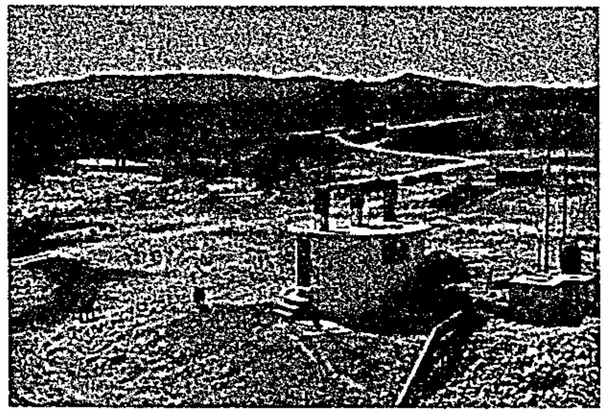
| | |
|---|---|
| Vertical type electrically driven KSB pumps | 2 Nos. |
| Total head | 75 feet |
| Motor output | 50 HP |

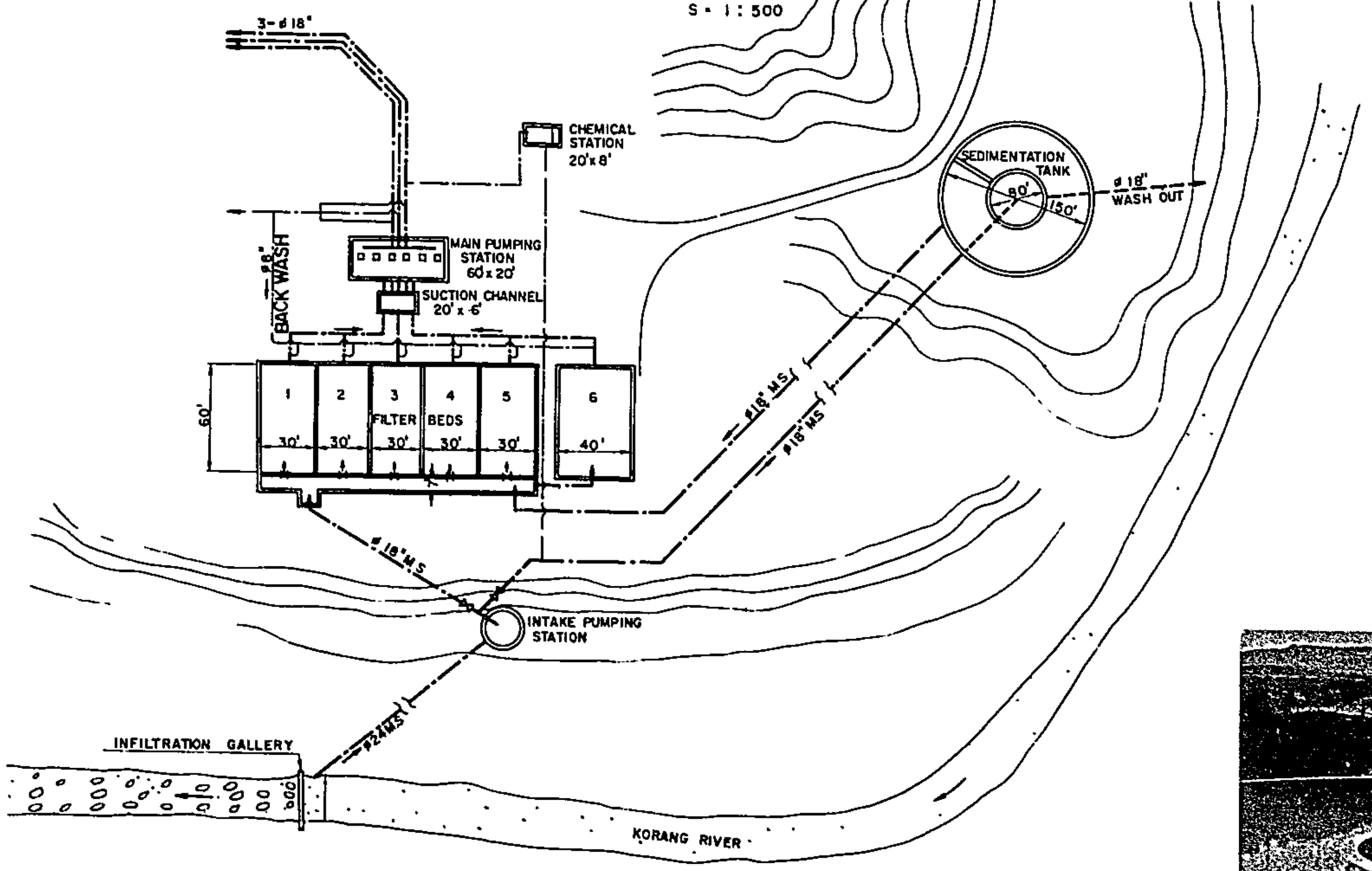
Purification Facilities

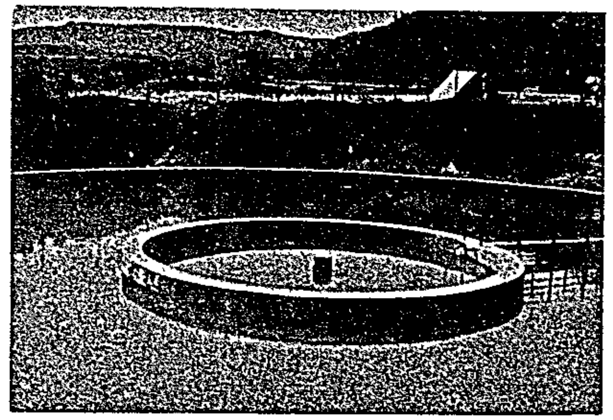
| | |
|---|---|
| Sedimentation basin | One No. |
| Effective volume | 0.098 mg (440 $m^3$) |

## FIG 3.1 -5 KORANG HEAD WORKS



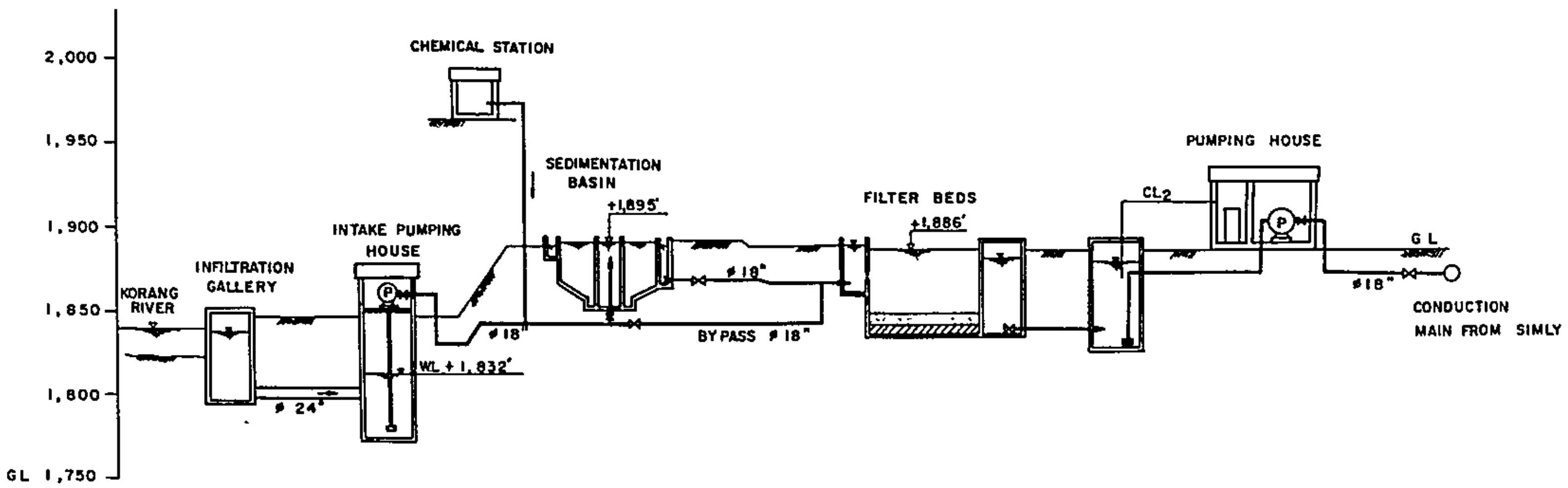




## FLOW DIAGRAM

S = NONE



| | |
|---|---|
| Sedimentation time | One hour |
| Capacity | 2.4 mgd |
| Filter beds | |
| Type (A) | 5 Nos. |
| Filter bed area | 1,800 sq. ft (165 $m^2$) |
| Type (B) | One No. |
| Filter bed area | 2,800 sq. ft (250 $m^2$) |
| Total filter bed area | 11,800 sq. ft (1,070 $m^2$) |
| Filtration rate for 2.4 mgd capacity | 8.5 gallons/h/sq. ft (10.8 m/day) |
| Pump Suction Wells | |
| Electrically driven centrifugal pumps | |
| Motor output | 80 HP |
| Pumping house | |
| Chemical room | |
| Alum feeding facilities | |
| Chlorinator | 2 Nos. |

Operating conditions of Korang Head Works are summarized as follows:

1) Floc formation in the sedimentation basin is found most efficient and this confirmes the most effective sedimentation being realized. Raw water from Korang River is generally low in pH and alkalinity compared with other head works (see paragraph 3.1.3), and the balanced condition between the dosage of alum and the raw water quality may have resulted in good flocculation.

2) The rate of filtration is 10.8 m/day. Since the standard rate of slow sand filtration is 2-5 m/day, the rate of this plant is twice as high as the ordinary case, which leaves a problem in its treatment efficiency.

   For the purpose of securing safer treated water, it is desirable to maintain a proper rate of filtration by either increasing the capacity of the filtration plant or reducing the quantity of treatment. In the summer season when the intake capacity of raw water decreases and, as a result, the flow of water to be treated decreases to about 0.5 mgd (at the time of drought flow, for example). This will be rather safe for the treatment efficiency

3) Backwashing of filters and sand replacement are carried out for the purpose of removing sludge deposited on filter bed due to filtration. Since backwashing is not effective because of the insufficient frequency and pressure of water applied, emphasis should be placed on the replacement of filter sand at specified intervals.

4) With a view to control the quality of treated water, it is necessary to run quality tests at regular intervals on both raw water and treated water. As no regular laboratory service is furnished at this plant, the National Health Laboratory should be utilized for that purpose.

c) Shahdra Head Works

Shahdra Head Works is a treatment plant, using surface water of Korang River branch, which is situated about 1.6 miles (2.5 km) north of the east end of Islamabad. Its design capacity is 1.6 mgd (7,200 $m^3$/day).

Raw water is taken into the intake conduit at a point upstream of Chang-Kas on a branch of Korang River, this raw water is directed through ø18" raw water mains and to the treatment plant situated about 1.0 miles (1.6 km) understream of the intake point, (See in Fig. 3.1-6).

The purification system consists of sedimentation and filtration by slow sand filters. Chlorination, as the final process, is provided in the clear water well.

Major facilities in Shahdra Head Works are as follows:

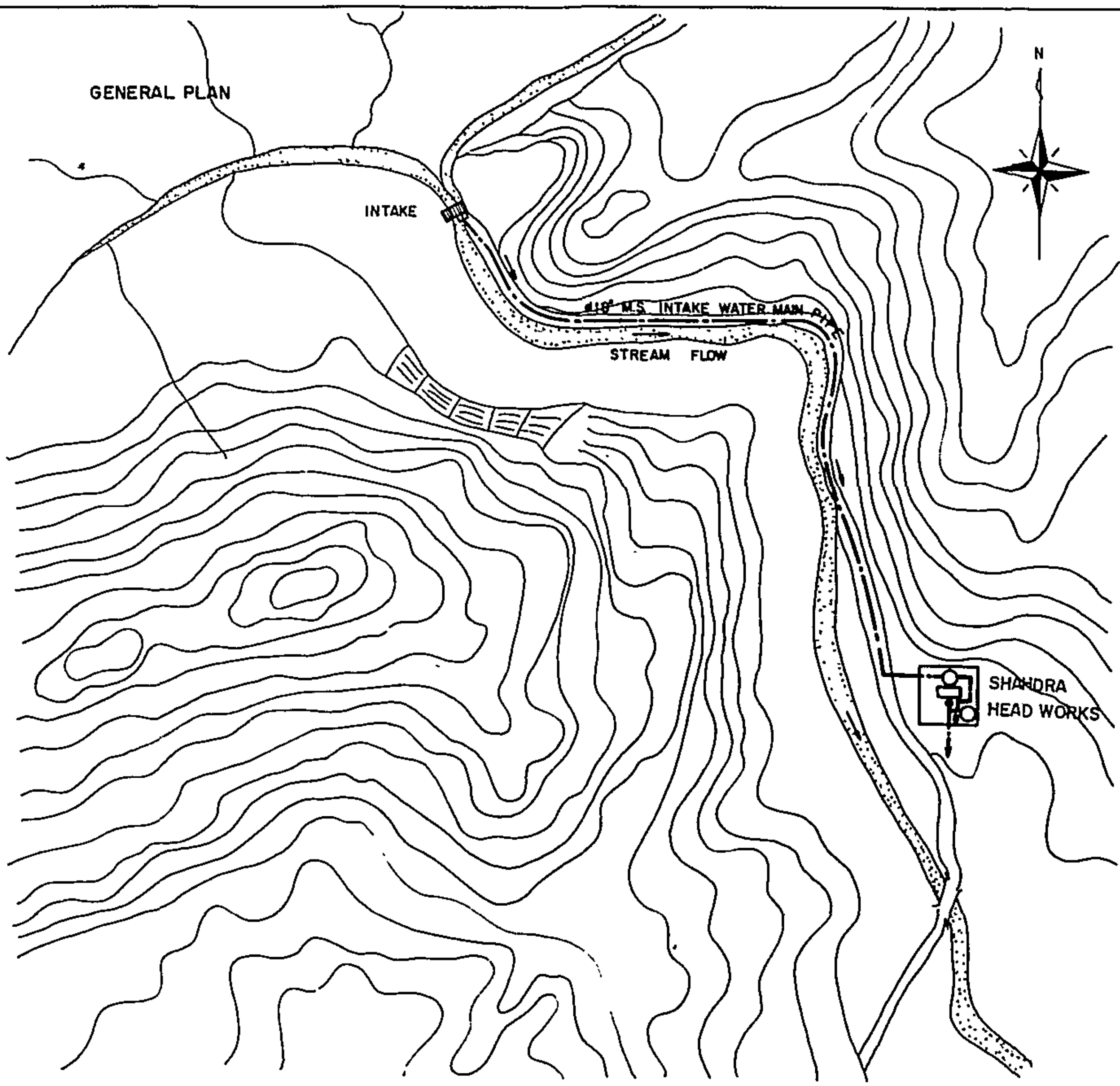
Intake Facilities

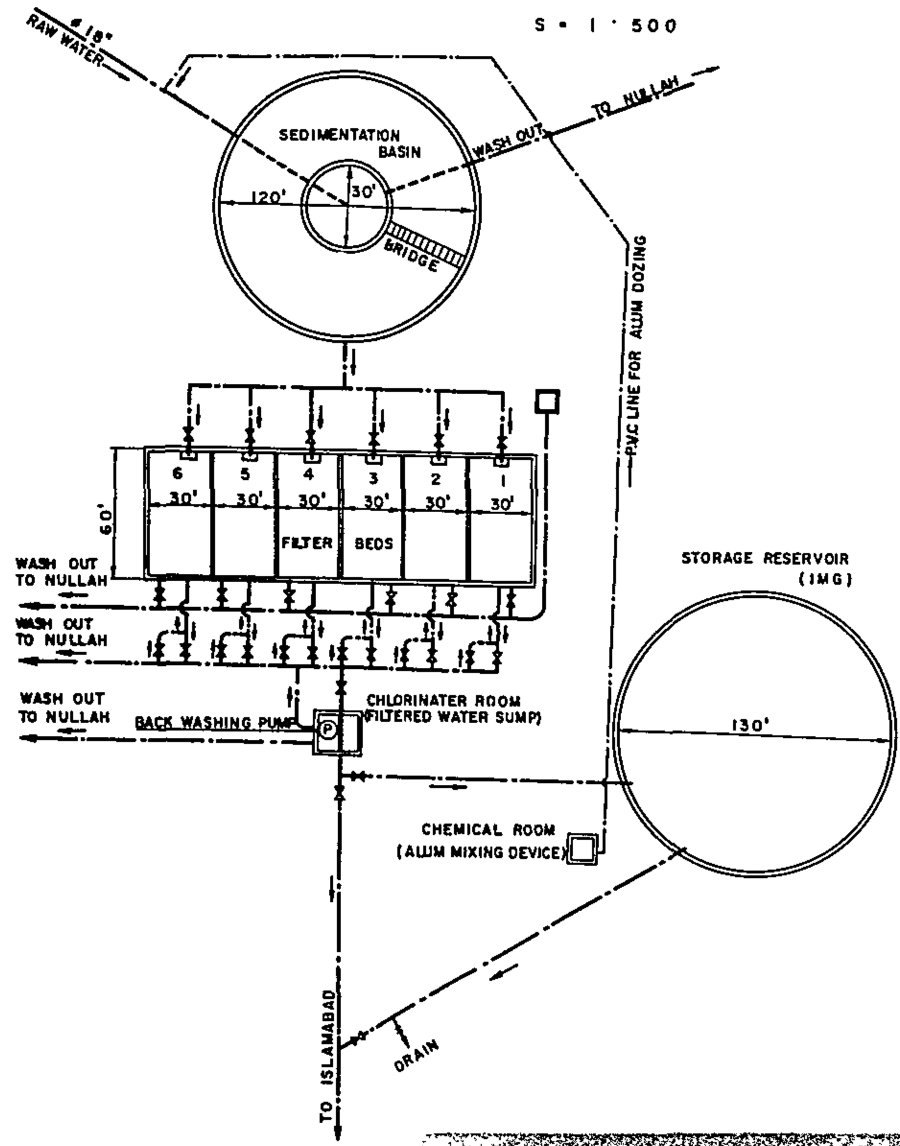
| | |
|---|---|
| Raw water main | ø18" MS pipe (1-3/4 miles distant from the source) |

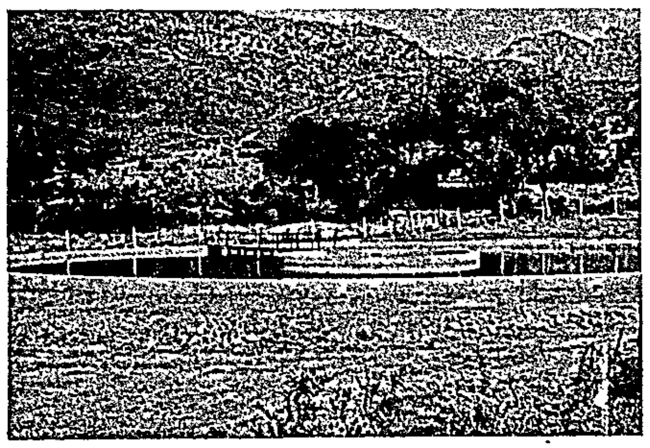
Treatment Facilities

| | |
|---|---|
| Sedimentation basin | One No. |
| Effective volume | 0.094 mg (440 $m^3$) |
| Filter beds | 6 Nos. |
| Unit filtration area | 1,800 sq.ft. (165 $m^2$) |
| Total filtration area | 10,800 sq.ft. (990 $m^2$) |

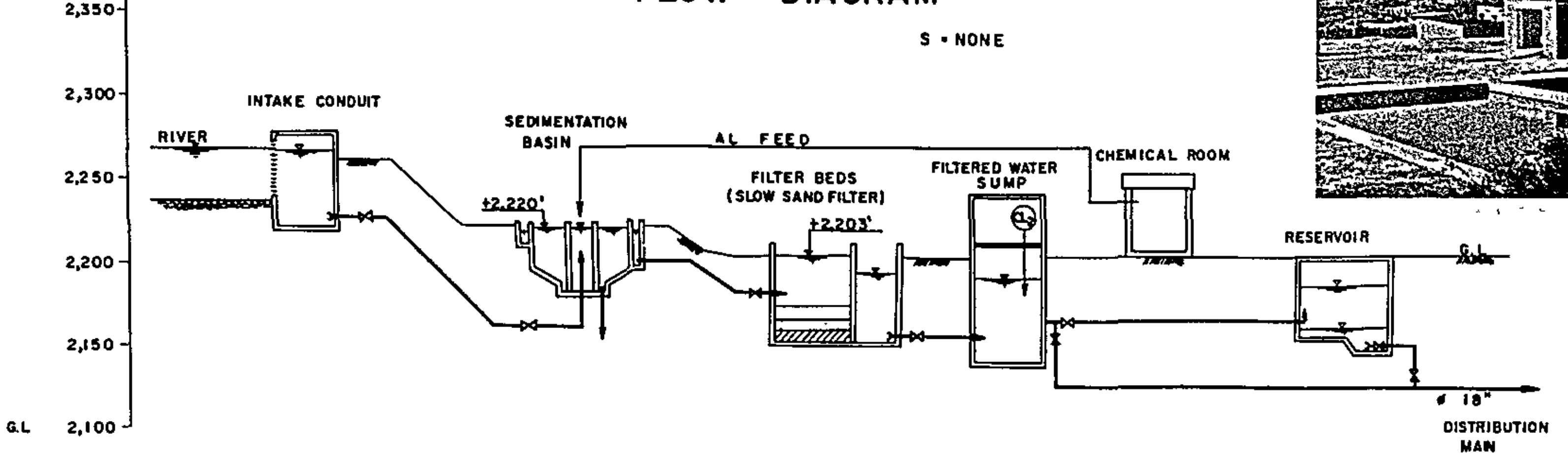
# FIG 3.1-6 SHAHDRA HEAD WORKS

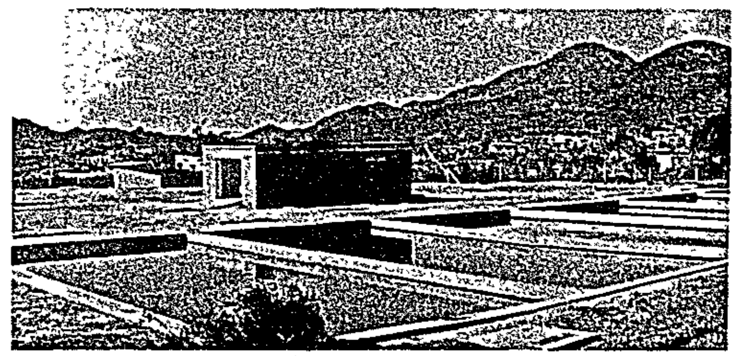


# FLOW DIAGRAM



| | |
|---|---|
| Average filtration rate for 1.6 mgd | 7.4 m/day |
| Backwashing pump for filter beds | |
| Vertical type KSB pump | |
| Capacity | 2 mgd |
| Total head | 80 feet |
| Motor output | 57.5 HP |
| Clean water reservoir | |
| Volume | 1 mg (4,500 $m^3$) |
| Detention time for 1.6 mgd capacity | 1/1.6 x 24 = 15 hours |
| Chemical feeding facilities | |
| Alum feeding facility | |
| Chlorinator | 2 Nos. |

Operating conditions of Shahdra Head Works are summarized as follows:

1) The intake conduit is such that a concrete conduit is laid across the river and is covered with concrete screen bars. When taken from the source, raw water contains impurities and soil, which may block the raw water main in the future. Therefore, the intake system or structure should be improved.

2) The sedimentation basin consists of a central coagulation tank and an outer settling tank. Chemical mixing and flocculation are run not by power but by the residual water head of raw water, which means that effective coagulation cannot be expected. In fact, flocculation sufficient for settling has not been realized.

   The detention time in the sedimentation basin is about one hour for the 1.6 mgd capacity of this plant. This is not enough compared with the normal detention time (2-3 hours), the fact of which may cause a problem in sedimentation if the raw water gets highly turbid.

3) Slow sand filters are backwashed by the washing pump installed on the water sump. It is not believed that backwashing has been effectively made, because of the

insufficient head and quantity of backwashing and of some defects in the structure of filter beds. Observation of filter sand indicates that a considerable quantity of sludge has been deposited on the surface with some of them solidified. Such filter beds will reduce the filtration capabilitv and will not permit designed filtration rate to be maintained.

d) Nurpur Head Works

Nurpur Head Works is situated about 1.9 miles (3.0 km) north of Sector F-4 and has a design capacity of 0.7 mgd (3,200 $m^3$/day).

Both this head works and Saidpur Head Works were planned and designed by Doxiades Associate of Athens, so that their plant structure is slightly different from such head works as Korang, Golf Course and G-10.

Raw water is taken from a small stream running down across Nurpur village, temporarily stored in a shallow well and then is directed to the treatment plant located near the intake point.

The purification system in this head works consists of sedimentation, slow sand filtration and chlorination. A flow diagram of the plant is shown in Fig. 3.1-7.

The sedimentation basin is a square type, horizontal flow sedimentation basin in which flocculators are coupled to the settling tanks. Flocculation is made by the round-the-end flow system, with a flocculation time of about 25 minutes. The sedimentation time of the settling tank is 3.5 hours.

Raw water is filtered by ordinary slow sand filters with a filtration rate of 8.4 m/day. Filtered water goes through in the filtered water sump and then is fed to the reservoir located inside the head works.

Major facilities in Nurpur Head Works are as follows:

Intake Facilities

Collecting well with collecting water pipe of ø15" (375 mm)

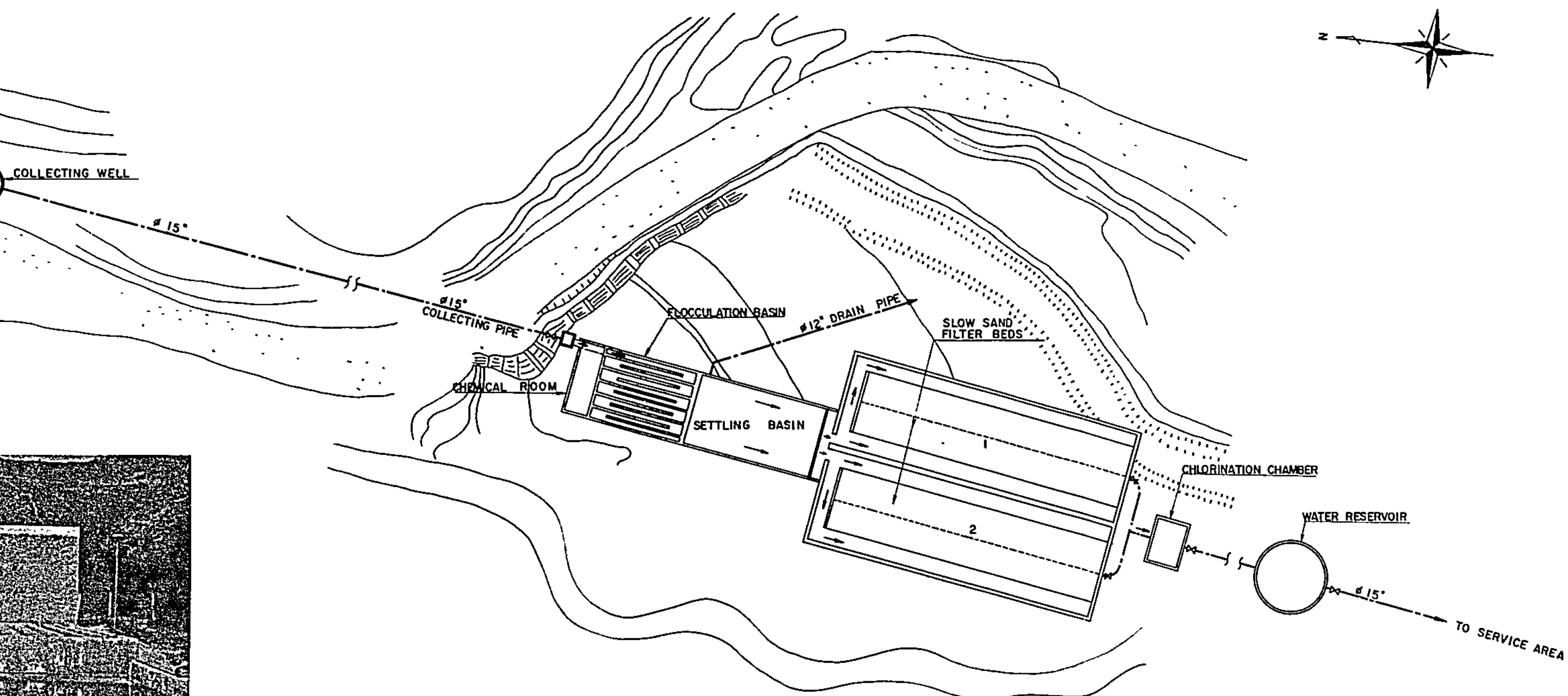
| | |
|---|---|
| Raw water main | ø18" MS pipe (1/2 miles distant from the source) |

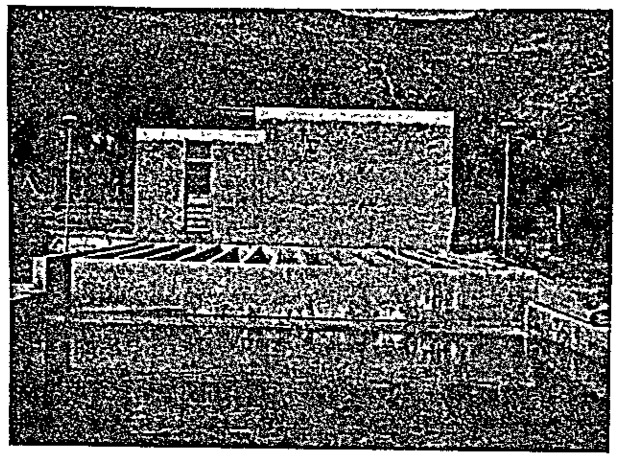
Treatment Facilities

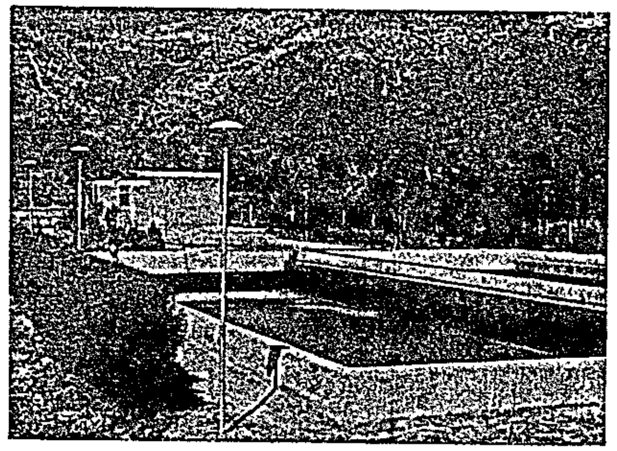
| | |
|---|---|
| Sedimentation basin | One No. |
| Flocculation basin | 1,620 cu.ft. (46 $m^3$) |
| Flocculation time | 25 minutes |

# FIG 3.1-7 NURPUR HEAD WORKS

S = 1 : 300

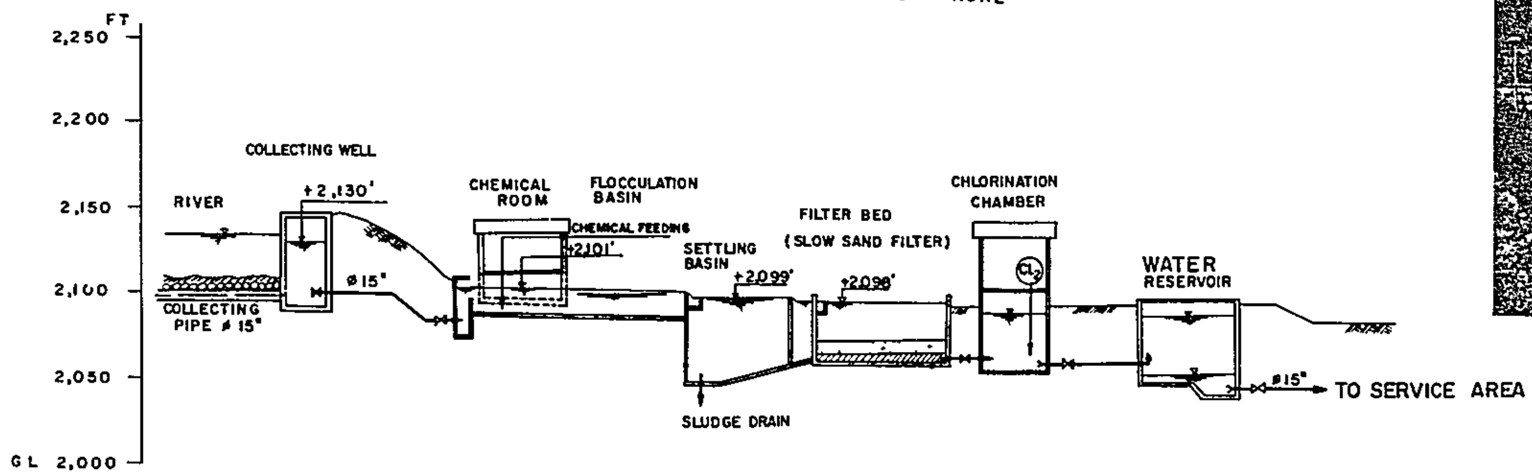




# FLOW DIAGRAM

S = NONE



| | |
|---|---|
| Settling basin | 12,600 cu.ft. (360 $m^3$) |
| · Setting time | 3.5 hours |
| Filter beds | 2 Nos. |
| Unit filtration area | 2,340 sq.ft. (220 $m^2$) |
| Total filtration area | 4,680 sq.ft. (440 $m^3$) |
| Ordinary filtration rate for 0.7 mgd discharge capacity | 6.3 gallon/h/sq.ft. (8.4 m/day) |
| Chemical room | |
| Alum feeder | |
| Chlorination chamber | |
| Filtered water sump | One No. |
| Chlorinator | 2 No. |
| Clear water reservoir | |
| Effective volume | 0.25 mg |

e) Saidpur Head Works

Saipur Head Works is located in Saidpur village, north of Sector F-6. Though its original design capacity was 0.7 mgd, current capacity is 2.7 mgd (12,200 $m^3$/day) since raw water is additionally introduced from G-10 Head Works.

As shown in Fig. 3.1-8, spring water is taken from the collecting wells on the hillside around the village and is introduced to the treatment plant. Meanwhile, raw water from G-10 Head Works joins the above-mentioned raw water at a junction well inside the plant.

The treatment system is identical in composition with that in Nurpur Head Works, except the filter beds which seem to have been extended later for treatment of raw water from G-10 Head Works. In the initial plan made by Doxiades Associate of Athens, filter beds designed as rapid sand filters were installed and connected to the sedimentation basin. But today, they are used as a part of the settling tank and raw water is filtered by the afore-mentioned slow sand filters.

Treated water is directly -- not through a reservoir -- supplied to the service area by gravity flow.

Major facilities in Saidpur Head Works are as follows:

## Intake Facilities

Collecting well with intake pipe, and inflow covered channel

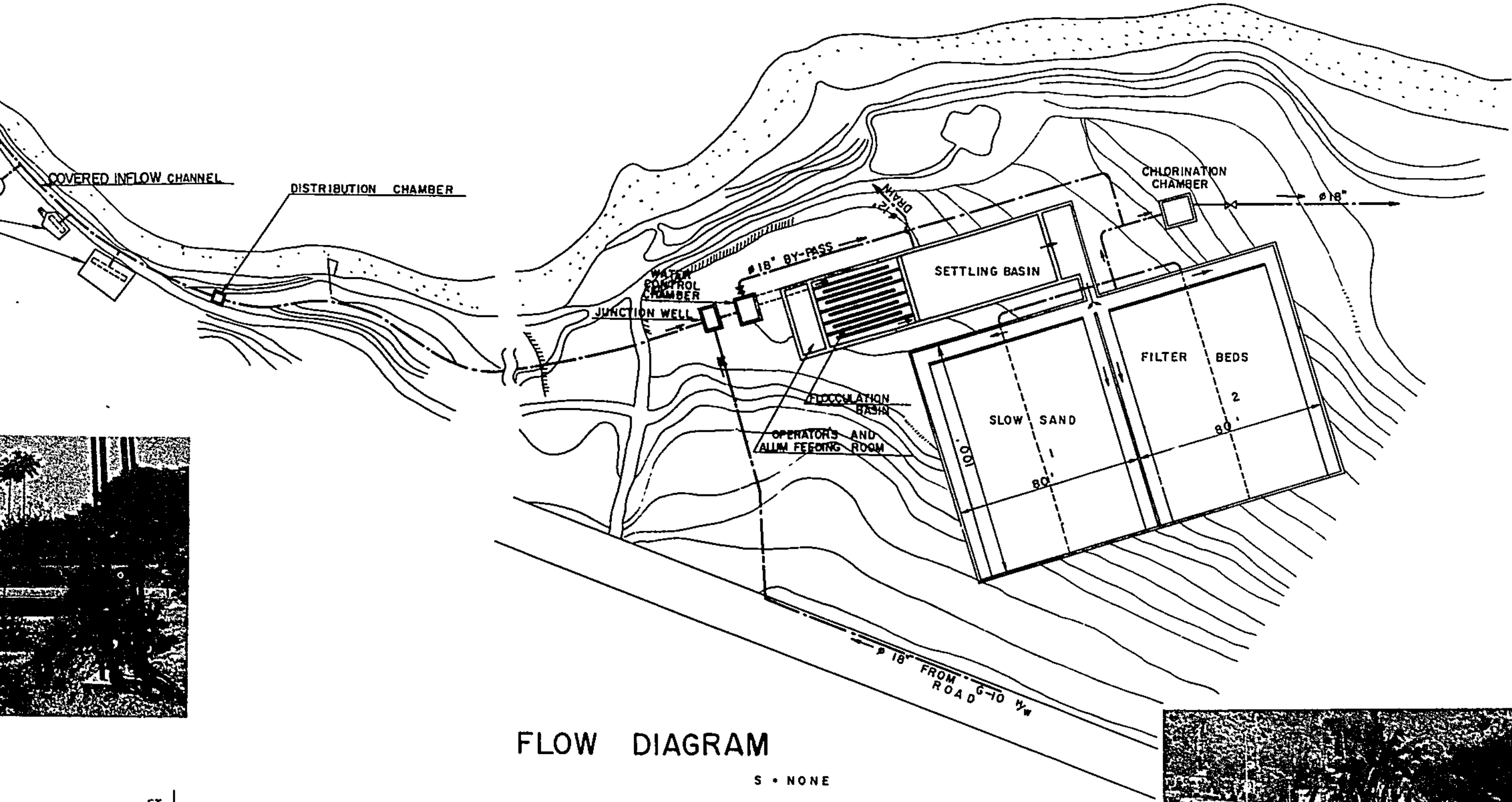
| | |
|---|---|
| Collection chamber | One No. |
| Raw water covered channel | 1/4 miles away from the collection chamber to junction well in filtration plant |

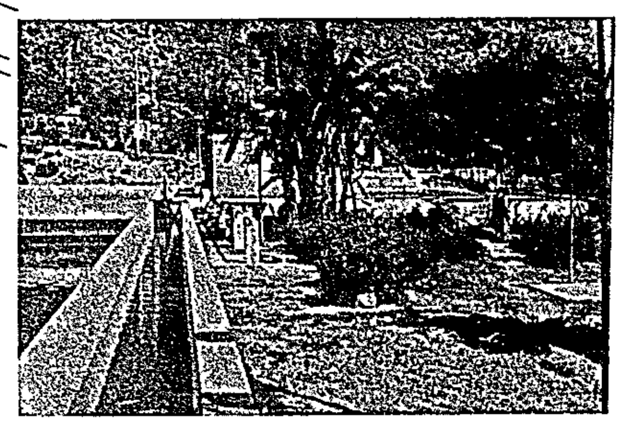
## Treatment Facilities

| | |
|---|---|
| Junction well | One No. |
| Sedimentation basin | One No. |
| Flocculation basin | 1,620 cu.ft. (46 $m^3$) |
| Settling basin | 12,600 cu.ft. (360 $m^3$) |
| Flocculation time | |
| for 0.7 mgd discharge | 25 minutes |
| for 2.7 mgd discharge | 6 minutes |
| Settling time | |
| for 0.7 mgd discharge | 3.5 hours |
| for 2.7 mgd discharge | 40 minutes |
| Filter beds | 2 Nos. |
| Unit filtration area | 8,000 sq.ft. 9,740 $m^3$) |
| Total filtration area | 16,000 sq.ft. (1,480 $m^3$) |
| Filtration rate | |
| for 0.7 mgd discharge | 1.5 gallon/h/sq.ft. (2.0 m/day) |
| for 2.7 mgd discharge | 7 gallon/h/sq.ft. (9.4 m/day) |
| Chemical room | |
| Alum feeder | |
| Chlorination chamber | |
| Filtered water sump | One No. |
| Chlorinator | 2 Nos. |

# FIG3.1-8 SAIDPUR HEAD WORKS

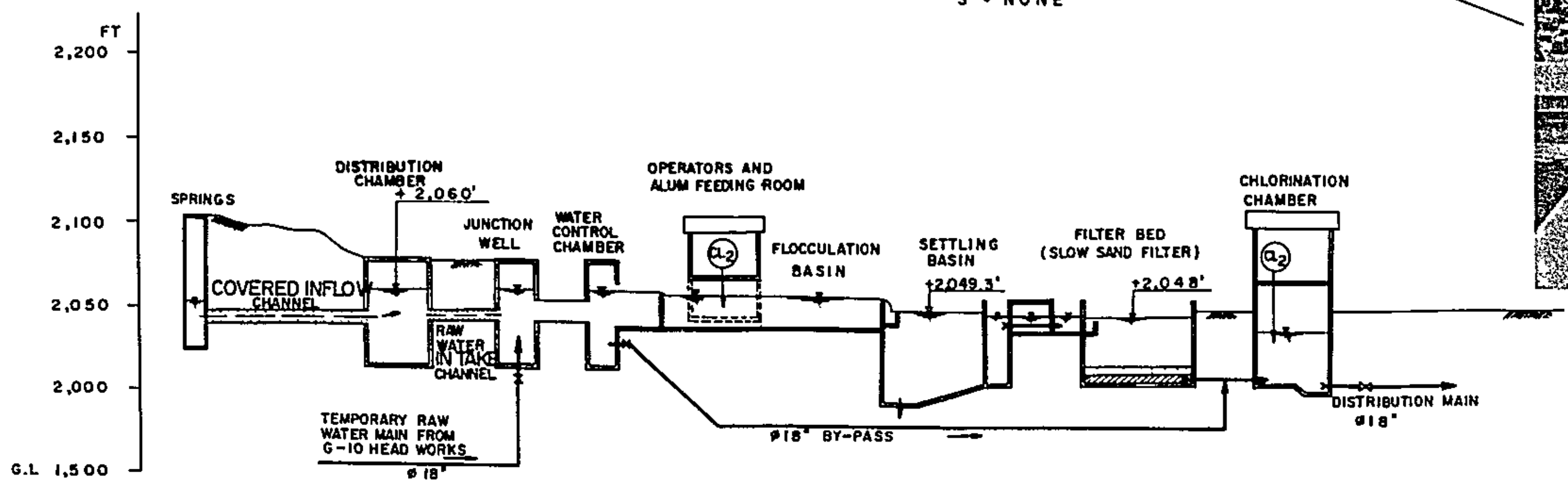
S = 1 : 300
S = 1 : 600



## FLOW DIAGRAM

S = NONE



The present condition of facilities and their control operation at Saidpur Head Works are summarized below:

1) Private houses are scattered near the water sources from which spring water is taken. This fact is undesirable from the sanitary requirements of the source. Therefore, the environment around the intake point should somehow be improved or the intake point itself should be moved to a more satisfactory place, in the near future.

2) Although the initial design capacity of the sedimentation basin was 0.7 mgd, the current capacity is 2.7 mgd. The flocculation time of 6 minutes and settling of 40 minutes are not practically useful for sedimentation.

3) The rate of filtration is 9.4 m/day for the 2.7 mgd and 2.0 m/day for the 0.7 mgd, the latter of which is preferable for water treatment. When the G-10 facilities are completed and raw water is no longer fed from the G-10 to this Saidpur Head Works, its load capacity will be less than 0.7 mgd and the treatment conditions for sedimentation and filtration will turn for the better. The present treatment works may be allowed as provisional arrangement.

f) Golf Course Head Works

This Head Works is located at the Golf Course near Rawal Lake and uses as its water source the raw water taken from a stream running from Sector F-6. Its design capacity is 2.5 mgd (11,200 $m^3$/day).

The purification system consists of sedimentation, slow sand filtration and chlorination. As shown in Fig. 3.1-8, raw water is taken from the intake pumping station located near the stream and is fed through a ø18" raw water main and to the sedimentation basin inside the Golf Course. After going through sedimentation and filtration, the water is chlorinated and supplied to Section F-6 by main pumps (distribution pumps).

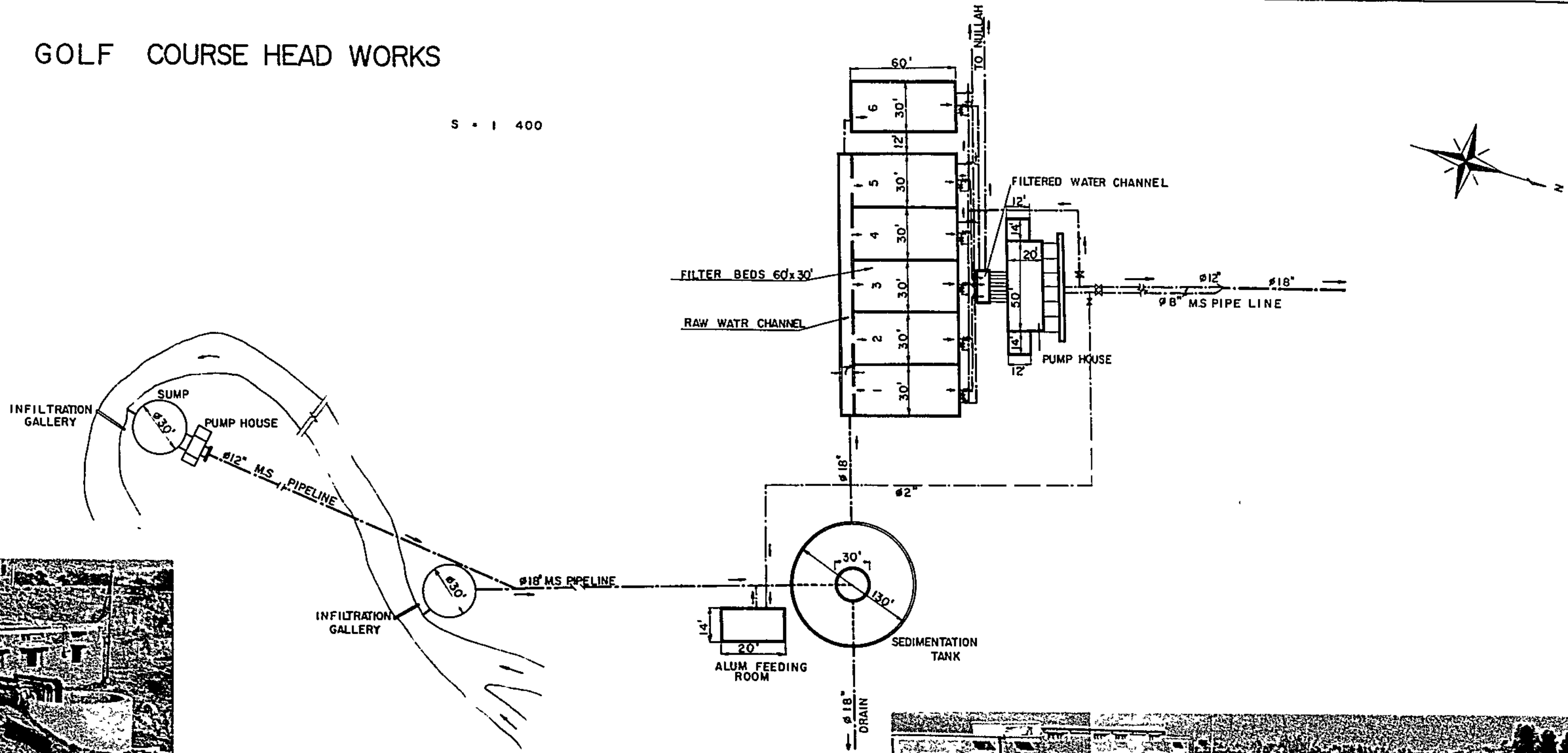
Filtered water sump

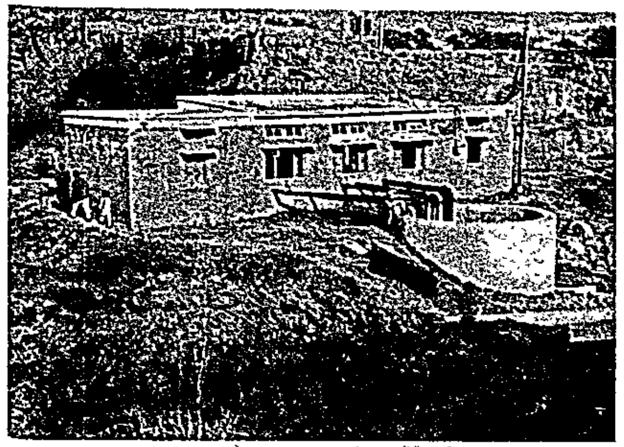
Main pumping station

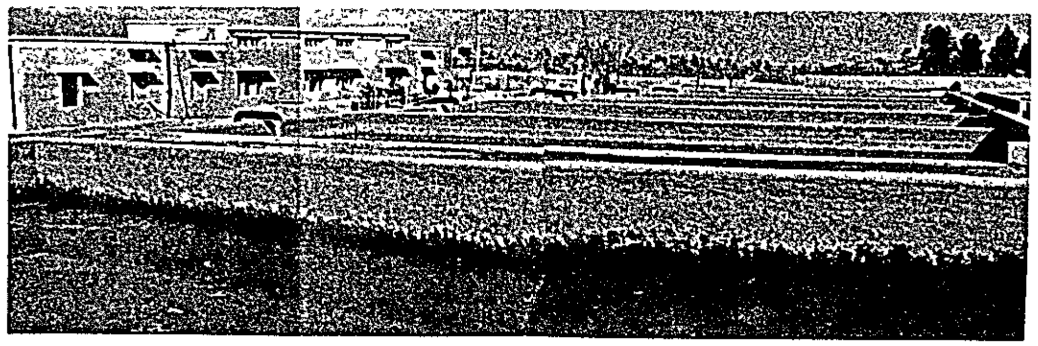
| | |
|---|---|
| Distribution pumps | 6 Nos. |
| Electrically driven centrifugal pump (KSB) | |
| Unit capacity | 500 gpm (2.3 $m^3$/min.) |
| Motor output | 80 HP |

# FIG 3.1 - 9 GOLF COURSE HEAD WORKS

S • 1 400

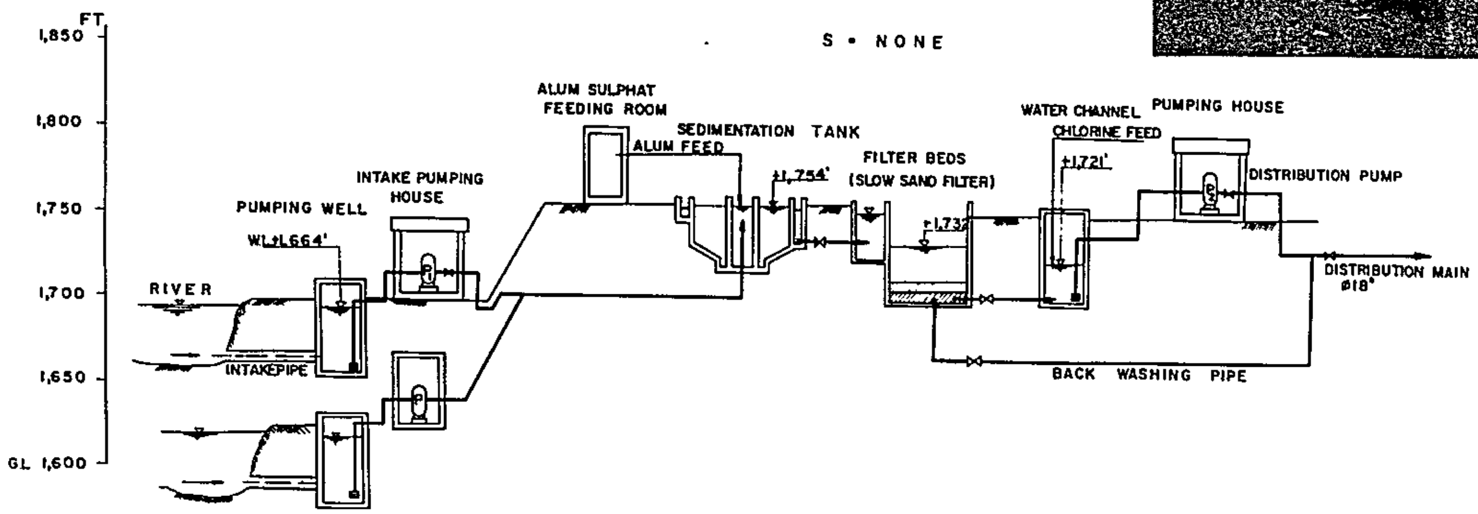




## FLOW DIAGRAM

S • NONE



The operation of this Head Works is summarized as follows:

1) Since the water source is a small stream, it is impossible to secure design capacity of water in summer seasons and the minimum intake quantity can decrease to about 1/3 or less than the design capacity (2.5 mgd). In such a case, the additional raw water is supplied from the lake channel.

2) In the sedimentation basin, alum is dosed in raw water only when it gets turbid.

Major facilities in Golf Course Head Works are as follows:

Intake Facilities

| | |
|---|---|
| Pumping well | 30' in diameter |
| Intake pumps | 5 Nos. |
| Electrically driven centrifugal pumps | |
| Pumping house | |

Purification Facilities

| | |
|---|---|
| Sedimentation basin | One No. |
| Effective volume | 0.098 mg (440 $m^3$) |
| Sedimentation time for 2.5 mgd discharge | One hour |
| Filter beds | 6 Nos. |
| Unit filtration area | 1,800 sq.ft. (165 $m^2$) |
| Total filtration area | 10,800 sq.ft. (990 $m^2$) |
| Average filtration rate for 2.5 mgd capacity | 9.6 gallon/h/sq.ft. |
| Alum sulphate feeding room | |
| Chlorinator | 2 Nos. |

3) Filtration rate is 11.3 m/day, which is too high. If raw water becomes remarkably dirty and, as a result, sufficient sedimentation cannot be realized, the filter beds are likely to be blocked faster than normal, resulting in a reduced rate of filtration and it is very difficult to maintain the aforementioned high rate of filtration for a long time. This means that the actual production will be reduced to a great measure.

g) G-10 Head Works

G-10 Head Works is situated within Sector G-10 along Murree Road and takes raw water from the stream running within the same section. Currently, as the filtration plant is under construction for the Head Works, raw water is introduced directly to Saidpur Head Works. Since the difference of the ground level between G-10 and Saidpur Head Works is about 450 feet (130 m), water is further boosted at the booster pumping station in Sector F-8 before being led to Saidpur Head Works. After the filtration plant is completed, raw water will be purified in this head works and be directed to the booster pumping station which will be located in Sector E-9 where the water will be further boosted. Then it will be transported to the proposed reservoirs now under construction on the hillside of Sector E-8.

Accordingly, the existing facilities consist mainly of intake facilities, which are as follows:

Intake Facilities

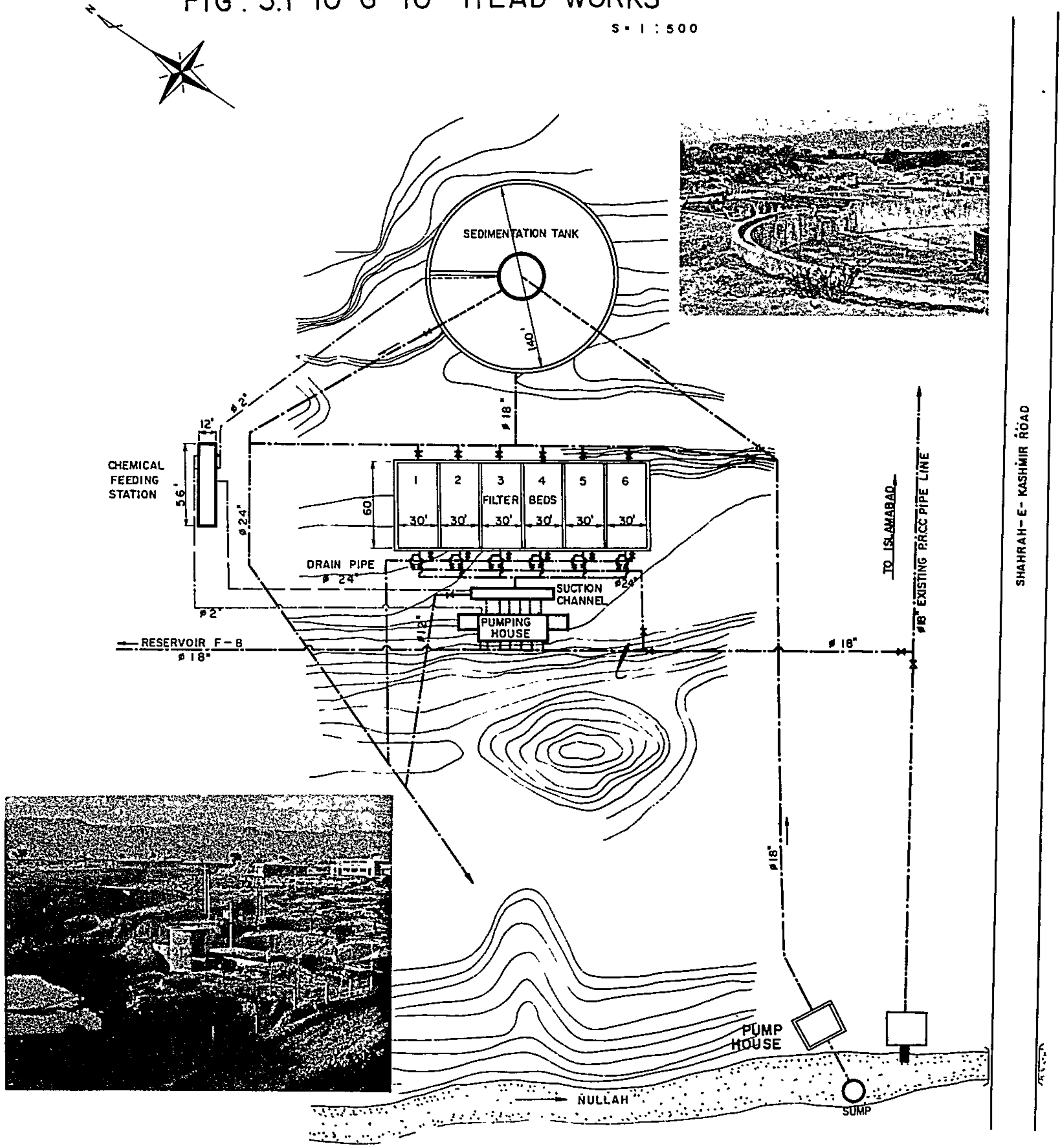
| | |
|---|---|
| Intake pumps | 2 Nos. |
| Electrically driven centrifugal pump | |
| Motor output | 150 HP |
| Second stage pumping facilities in booster pumping station in F-8 | |
| Booster pumps | |
| Electrically driven centrifugal pump | |
| Motor output | 150 HP |

The filtration plant proposed is as follows:

| | |
|---|---|
| Design capacity | 3 mgd (13,500 $m^3$/day) |
| Intake Facilities | |
| Pumping suction well | 5' x 5' |
| Intake pumps | 2 Nos. |
| Deep well turbine pump | |
| Unit capacity | 1,050 gallons/minute |
| Total head | 70 feet |
| Motor output | 50 HP |

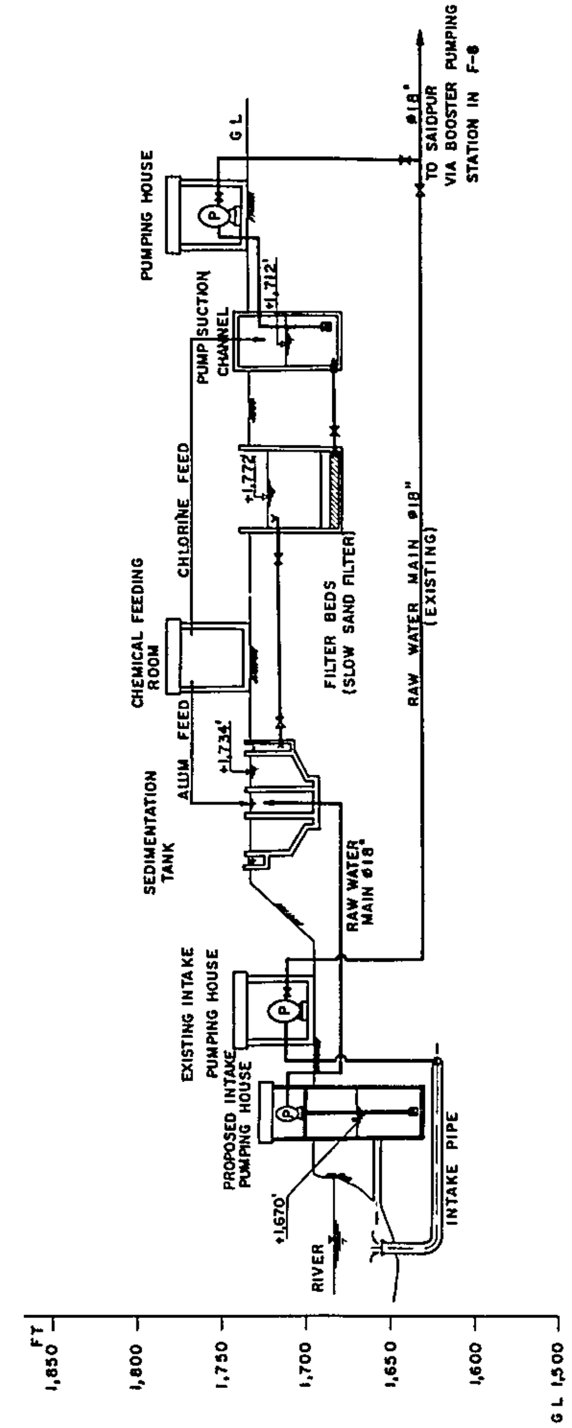
# FIG. 3.1-10 G-10 HEAD WORKS

S = 1 : 500




# FLOW DIAGRAM

S = NONE



Purification Facilities

| | |
|---|---|
| Sedimentation basin | One No. |
| Filter beds | 6 Nos. |
| Unit filtration area | 1,800 sq.ft. |
| Total filtration area | 10,800 sq.ft. |
| Average filtration rate for 3 mgd capacity | 11.6 gallons/hr/sq.ft. |
| Filtered water sump (Pumping suction well) | |
| Chemical feeding facilities | |
| Alum feeder | One unit |
| Chlorinator | 2 Nos. |
| Main pumps for pumping up to second stage pumping station in F-8 | 4 Nos. |
| Electrically driven centrifugal pump | |
| Motor output | 150 HP |

Booster Pumping Station

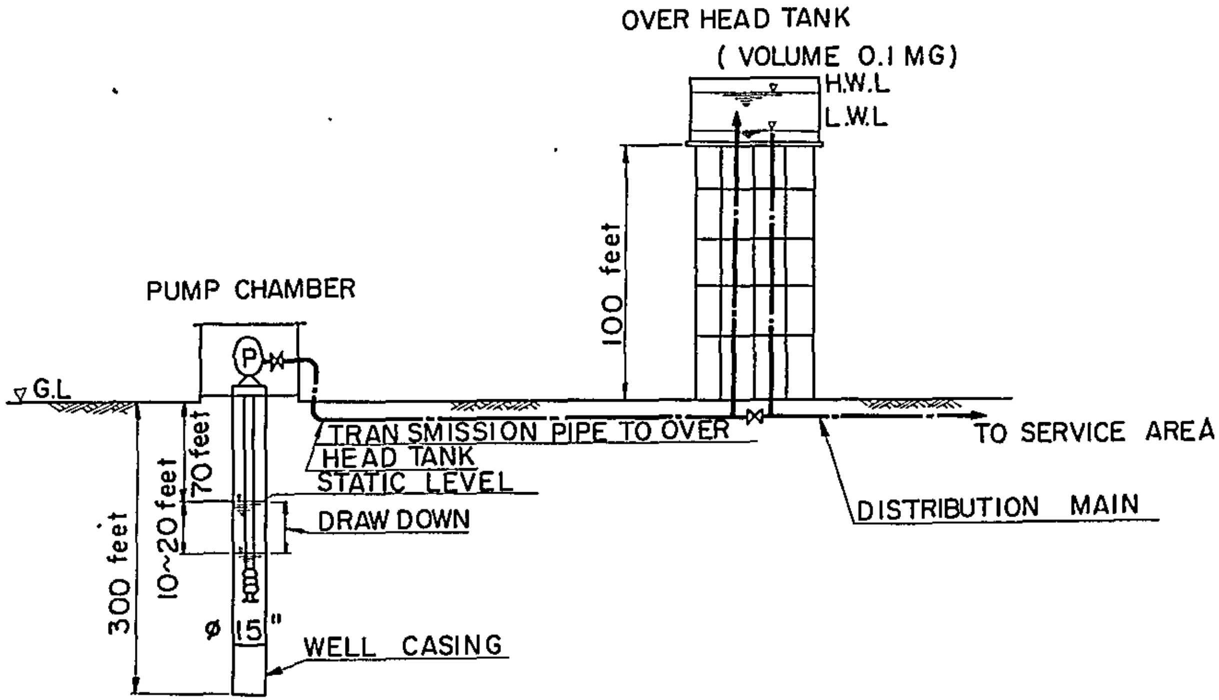
| | |
|---|---|
| Second stage pumps | 4 Nos. |
| Electrically driven centrifugal pump | |
| Motor output | 150 HP |
| Pumping suction well | |
| Pumping house | |

h) Tube-wells

At present, six tube-wells are located in Sectors G-5, G-7, G-9, F-8 and I-9. Locations of these tube-wells are represented in Fig. 3.1-1. The tube-wells installed in Sectors G and F are directly connected to distribution mains, while those in Sector I-9 have overhead tanks from which water is fed to the sector by gravity flow. Fig. 3.1-11 shows a flow diagram of the tube-well in Sector I-9.

Generally, it may safely be said that, in the case of these tube-wells, the water level under ground is low and the draw-down under pumps fluctuates to a great extent. Only No. 5 tube-well in

FIG 3.1-11 FLOW DIAGRAM AT TUBE-WELL IN SECTOR I-9



Sector G-5, can be operated continuously for 24 hours a day. Other tube-wells can operate for 21 hours at a maximum; Tube Well No. 7 in Sector G-7 is limited to only 4 hours of operation per day. The average discharge capacity, computed from the pumping capacity, is about 0.37 mgd (1,700 $m^3$/day) per well. Also, the intake capacity per day per tube-well, computed from actual working time, is 0.23 mgd (1,200 $m^3$/day). (See Table 3.1-7) Judging from these data, the tube-wells may be judged to be very inefficient as compared with many deep wells drilled under favorable conditions.

Ordinarily, tube-wells installed for the purpose of collecting ground water can cause rapid clogging of well screen and gravel shrounding, resulting in a sharp drop in the yield, as they are operated for a long time. The tube-wells in Islamabad have been operating for seven years since their installation and it should be noted that these tube-wells may suffer from a rapid reduction in yield or become inoperative in the near future.

### 3.1.5 Transmission Main

#### a) Simly Transmission Main

The Simly Transmission Main starts at Simly Filtration Plant extending to Sector F-4 over a distance of 16.0 miles (25.8 km).

As illustrated in Fig. 3.1-12, the pipeline is routed from Simly Plant to the south along Soan River, crossing Tamara hills through a tunnel (200 m in distance), then directed approximately to southeast, turning to northwest in Muhvi village and crossing Nalakas, Gumreh Kas and Korang Rivers along the road around the National Park. On Korang River, the pipeline connects the conduction pipe from Korang Head Works. Then the line crosses Muree Road, routing from Chang Kas River to nearly west, jointing the Shahdra Conduction Main, going along the road around the Green Space Area and reaching the termination point in Sector F-4.

As shown in Fig. 3.1-12, the pipeline rises and falls rather frequently since it crosses rivers such as Nala Kas, Gumreh Kas and Korang. Especially at Gumreh Kas River, the maximum head of the line reaches 450 feet (130 m) of water head and many troubles as mentioned later have occurred there.

One line of PRCC pipe ϕ36" (900 mm) has been laid. Currently, CDA is laying another line of the same type pipe along the existing pipeline.

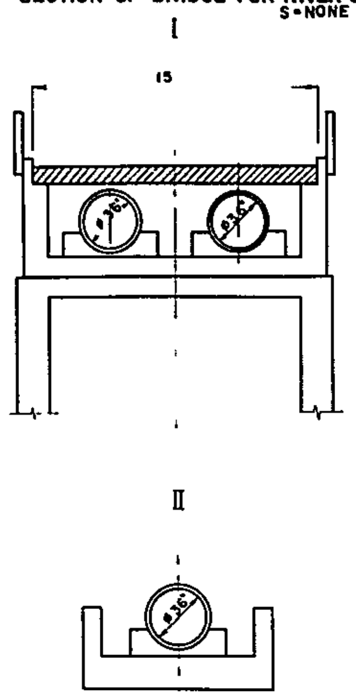
The transmission main is to be extended to the proposed reservoir (in Section F-5) which will be installed in the future. At present, however, the line is connected to the distribution pipe at the termination point, through which water is supplied directly to the service area. The difference of the ground level between Simly Filtration Plant and the proposed reservoir is 154 feet (46.5 m)

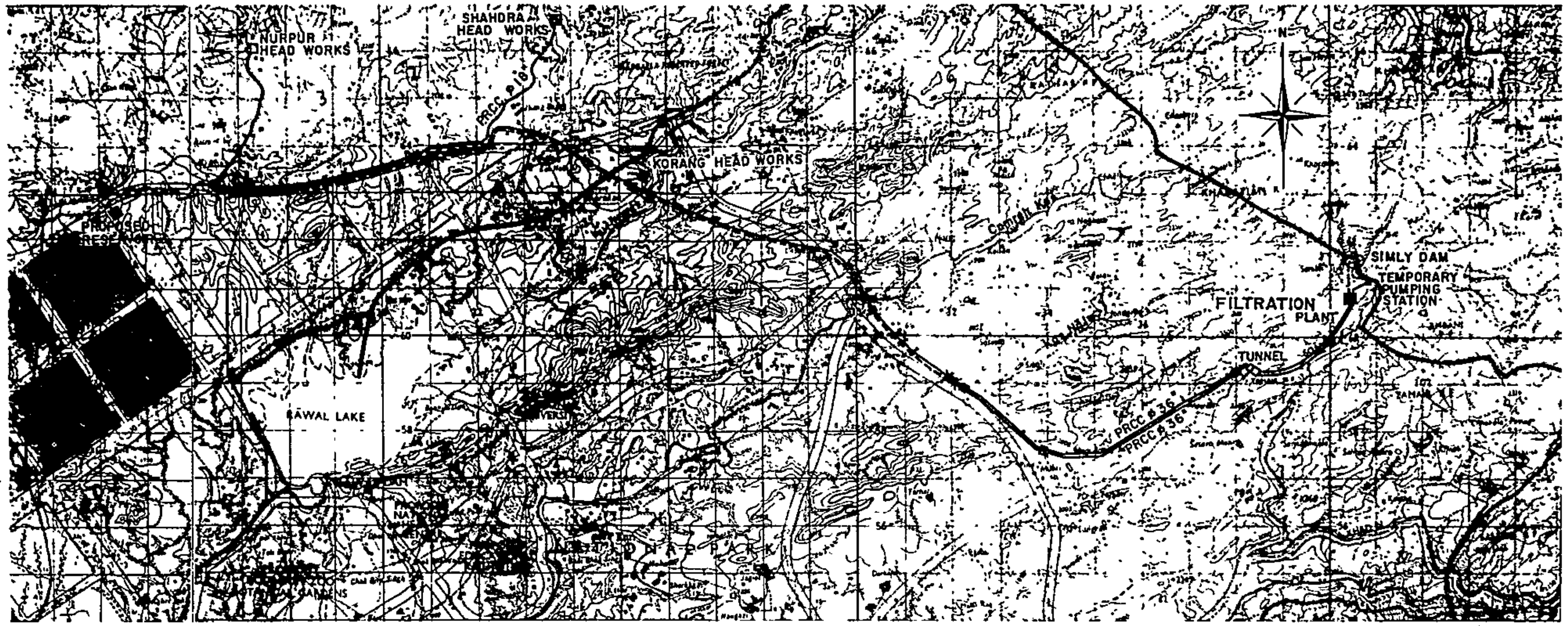
Table 3.1-7 List of Existing Tube-Wells

| S. No. | Particular | Location | Casing of Well | | Installed Pumps | | | | Discharge | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Diameter | Depth | NOS | Capacity | Head | Motor Output | Running Time | Average Discharge per Day |
| | | Sector | | | | GPM | Feet | HP | Hours | MGD |
| 1. | T.W. | G - 5 | | | | No use | | | | |
| 2. | T.W. NO5 | G - 5 | 12" | 270' | 1 | 120 | 270 | 15 | 24 | 0.27 |
| 3. | T.W. NO2 | G - 7 | 12" | 450' | 1 | 200 | 200 | 30 | 4 | 0.03 |
| 4. | T.W. | F - 8 | 12" | 400' | 1 | 260 | 380 | 50 | 21 | 0.30 |
| 5. | T.W. G-9 | G - 9 | 12" | 400' | 1 | 280 | 325 | 50 | 20 | 0.32 |
| 6. | T.W. NO1 | I - 9 | 15" | 300' | 1 | 300 | 300 | 40 | 12 | 0.22 |
| 7. | T.W. NO2 | I - 9 | 15" | 300' | 1 | 350 | 300 | 50 | 24 | 0.50 |
| | Total | | | | 6 | GPM 1,510 MGD (2.2) | | HP 235 | (17.5) | MGD 1.64 |

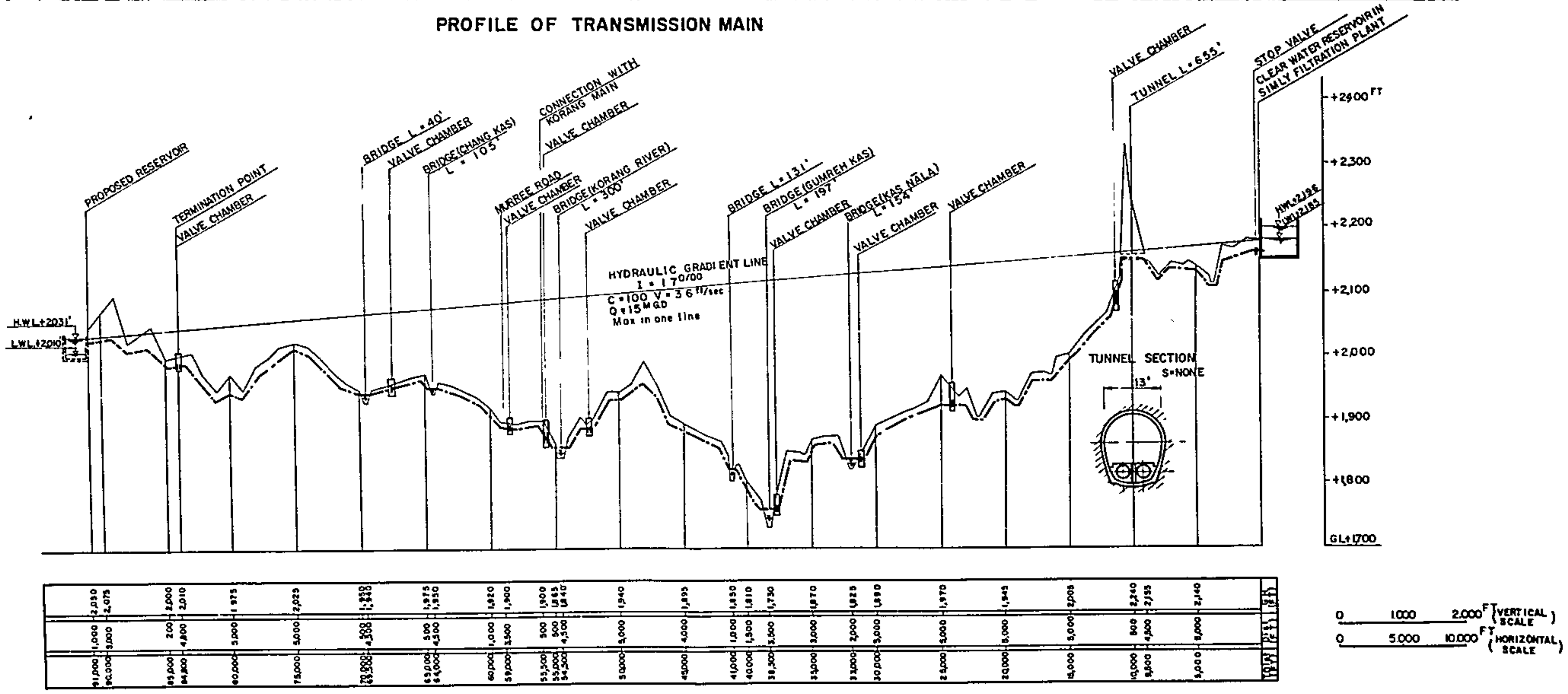
# FIG3.1-12 TRANSMISSION MAIN FROM SIMLY TO ISLAMABAD

SECTION OF BRIDGE FOR RIVER CROSSING
S=NONE

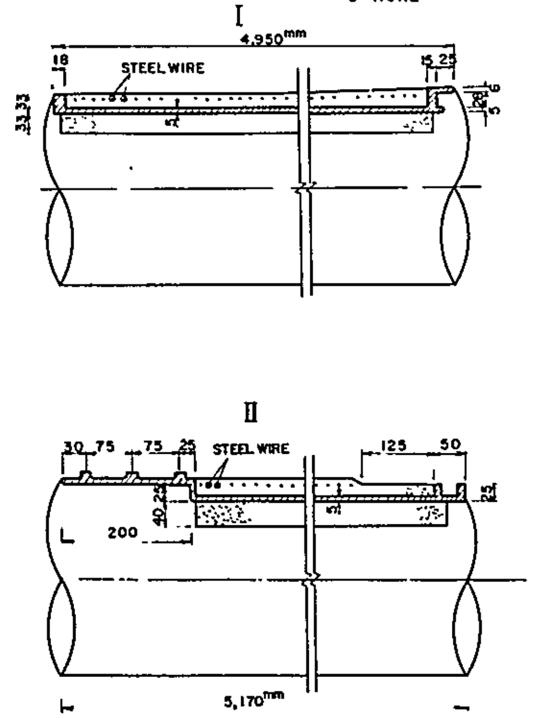





PROFILE OF TRANSMISSION MAIN




ø36" P.R.C.C PIPE SECTION
S=NONE



and the average slope of the line is 1.7/1000 (or 1.7 o/oo).

The Japan Survey Team conducted field survey on the entire line of Simly Conduction Main for about four days to check the general installation condition, including condition of pipes and valves for water leakage, etc. The results are summarized as follows:

Condition of Pipeline

1) The pipeline, in the aggregate, is laid under special piping roads or public roads. This facilitates pipeline maintenance, but there are many ups and downs and river crossings. Thus it cannot be said that the profile of the pipeline is favorable. To meet such conditions many air valves have been installed, some of them even at low levels contrary to the principle that they should be located at high levels, and, as will later be discussed, with the difficulties, these have caused water leakage.

2) The pipe has been laid with an overburden of about 1.5-2.0 m. However, some exceptions were found where the overburden is not sufficient with incomplete backfilling.

3) Valve chambers are provided on the pipeline at spacings of about 10,000 feet (3 km). Each of these valve chambers is furnished with manhole (for inspection of the pipeline), main valve, air valve, surge relief valve, etc. But as the chamber is not complete with a cover, it is exposed to air and its interior is filled with water including rain water and leaks from valves.

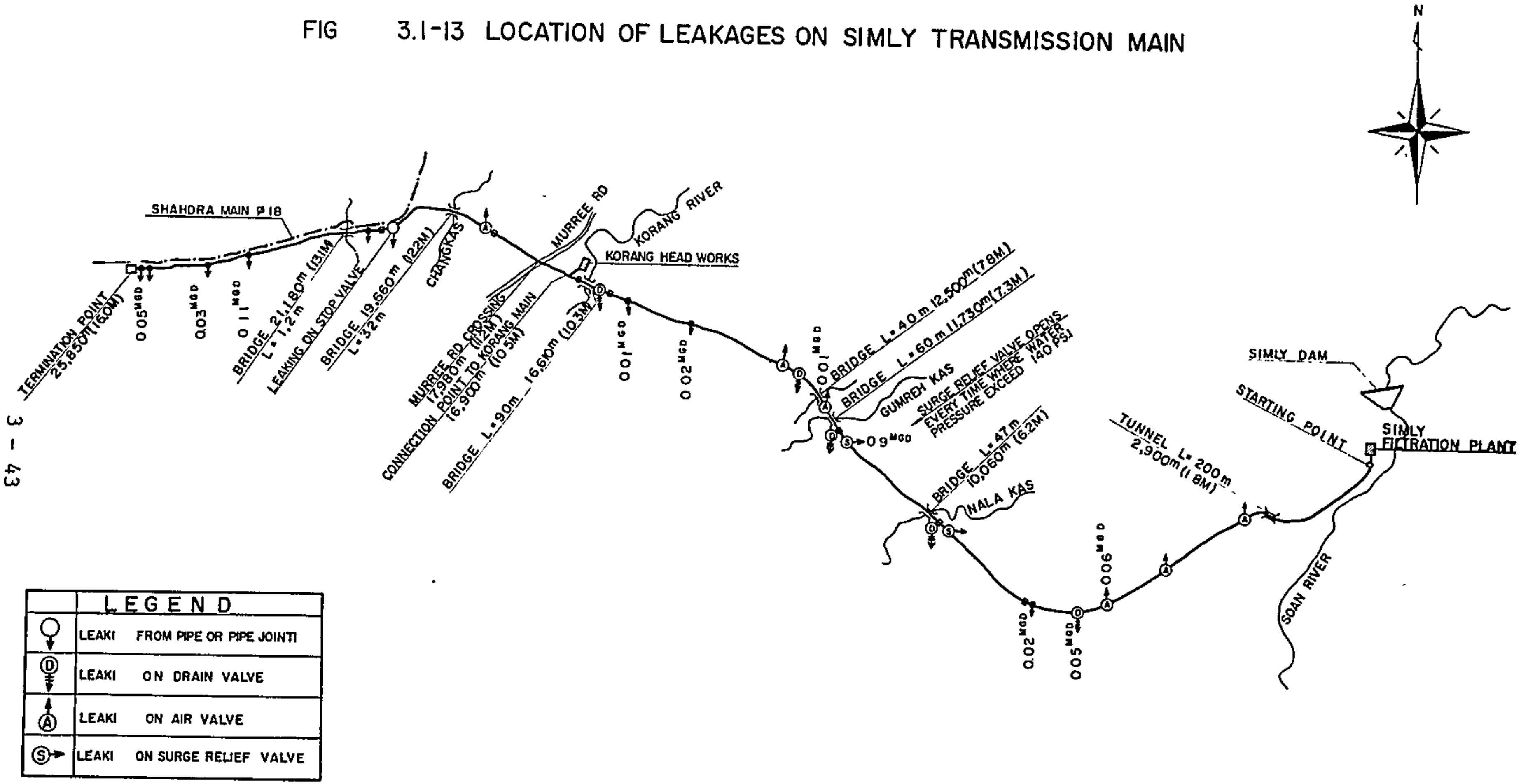
4) The pipeline crosses rivers on bridges or by providing a siphon. As shown in Fig. 3.1-12, a bridge is used not only as a walkway but as the means for pipe-laying. Two PRCC pipes ø36" have been installed on the bridge (one for future expansion).

5) There is a tunnel for pipeline in a place 8,900 feet (2.9 km) away from Simly Filtration Plant. This tunnel is lined with concrete up to 60 feet from the portal of Islamabad side. All the other inner walls of the tunnel are supported with H-shape steel members. The roof of the tunnel near the entrance to Islamabad has partially fallen. Thus the passage for maintenance personnel is not safe.

Pipes, Valves and Other Materials

1) The pipes used is a locally made PRCC pipe (prestressed rainforced cement concrete pipe) with rubber ring joints. PRCC pipes having steel core can be used for high water pressure. Joints of the pipes are welded and not coated.

FIG 3.1-13 LOCATION OF LEAKAGES ON SIMLY TRANSMISSION MAIN



Such welded joints can easily corrode, causing water leakage.

2) Most of the valves used are locally made ones, which have allowed water leakage or been inoperative because of their poor materials and structural defects. Main valves, air valves, surge relief valves, etc. are not protected by valve chambers, with the result that some of these parts have been lost or damaged, causing water leakage.

Leakage

Water leakage were found at 22 locations on the pipeline, as shown in Fig. 3.1-13.

Table 3.1-8 shows the water leaks. It shows causes of leakage, as well as the quantity of leak water confirmed at the site.

Table 3.1-8

| | Description | Nos. | Quantity of leak water |
|---|---|---|---|
| (a) | Leaking from pipe or pipe jointing | 7 | 0.24 mgd |
| (b) | Leaking on drain valve | 6 | 0.05 mgd |
| (c) | Leaking on air valve | 7 | 0.07 mgd |
| (d) | Leaking on surge relief valve | 1 | |
| (e) | Wastage on surge relief valve in the lowest point of conduction main | 1 | 0.9 mgd |
| | Total | 22 | 1.26 mgd |

Note: The quantity of leak water listed above does not cover all leakage but only the leakage that was confirmed. The delivery of Simly Conduction Main during the survey was 2.5 mgd.

Description on Table 3.1-8 discloses most leakages are on pipes or pipe joint, and air valves, followed by leakage from drain valves. The total quantity of leak water amounts to 1.26 mgd which is about 50% of the delivery quantity. In addition to the leakage from pipes, joints and valves, another cause for the loss is the wastage on the surge relief valve -- a valve installed on Gumureh Kas River running at the lowest level of the Simly pipeline. At this point, the maximum water head reaches as high as 450 feet, whereas the limited pressure of the surge relief valve is 150 psi. When the actual pressure exceeds this limit, water is automatically relieved, thus maintaining the pipeline at a safety level by reducing the actual pressure on the pipeline by way of releasing water from the surge relief valve. It is therefore obvious that considerable amount of wastage of water is occurring due to the difference of maximum water head and the limited pressure of the surge relief valve.

In order to eliminate the wastage, it will be necessary to replace the current pipes near the surge relief valve with new pipes, fittings, valves, etc. that can withstand high water pressure.

In fact, the ϕ36" main valve in the valve chamber mentioned above was found cracked and deformed due to shortage of their pressure resistance.

### 3.1.6 Distribution System

#### a) Reservoirs

Table 3.1-9 shows the reservoirs installed within the service area, classified by water sources, filtration plants or head works.

Table 3.1-9

| S. No. | Situation | Discharge (mgd) | Reservoirs | | | Remarks |
|---|---|---|---|---|---|---|
| | | | Location | Nos. | Capacities (mg) | |
| 1 | Simly F/P | (24.0)<br>5.0 | Sec. F-5 | (1) | (7.0) | Proposed reservoir |
| 2 | Korang H/W | 2.4 | | - | - | |
| 3 | Shahdra H/W | 1.6 | Shahdra H/W | 1 | 1.0 | |
| 4 | Nurpur H/W | 0.7 | Nurpur H/W | 1 | 0.25 | |
| 5 | Saidpur H/W | 0.7 | Saidpur H/W | 1 | (1.0) | Under construction |
| 6 | Golf Course H/W | 2.5 | | - | - | |
| 7 | Proposed Golf Course H/W | - | Shakar-perian Hill | 1 | 0.45 | |
| 8 | G-10 H/W | 2.0 | N. Corner of Sec. F-8 | (2) | (2.00) | Under construction |
| 9 | Tube-wells | 1.64 | Sec. I-9 | 2 | 0.20 | Overhead tanks |
| | Total | 16.54<br>(35.54) | | 6<br>(9) | 1.9<br>(11.9) | 1.9/16.54 x24=2.7 hrs.<br>14.15/35.54 x24=9.6 hrs. |

From Table 3.1-9 it is seen that a total number of the reservoirs currently available is 7 (seven) with a total capacity of 11.9 mg (49,000 $m^3$). The reservoir of the Simly water supply system has been proposed and their construction has been started. Both the proposed reservoir of the G-10 Head Works and Saidpur reservoir are under construction and will be able to accept water for storage within the year of 1970. All reservoirs in Sector I-9 are of overhead tank type and one reservoir of such type is located to each tube-well.

The above informations have revealed that five reservoirs are currently in operation with a total capacity of 1.9 mg (8,900 $m^3$). The detention time for the 16.54 mgd discharge capacity is 2.7 hours only. If Simly and G-10 reservoirs are completed, the detention time will be about 9 hours (calculated from Table 3.1-9), which meets the standard of 6-8 hours required for ordinary water works and which secures safety in water supply.

The purpose of reservoirs is to adjust the difference between maximum day demand and maximum hour demand, and to store water for emergency use, for example, fighting a fire. If the capacity of a reservoir is insufficient, the relation between water production and demand will be inbalanced causing water shortage problems. The aforementioned detention time of reservoirs of 8-6 hours is a value obtained empirically.

For these reasons, Simly and G-10 reservoirs should be completed as early as possible. For the Simly reservoir, however, the problem is involved in its correlation between the location and service area. The optimum location of the reservoir is to be decided on the basis of what range of area to be served by the total reservoirs when water can be transmitted at the rate of 24 mgd from the Simly Filtration Plant in future. Nevertheless, the proposed locality of the Simly reservoir is within Sector F-5.

b) Distribution Main System

The service areas where distribution mains and distribution pipes have been completely equipped are seven sectors, that is, F-5, -6 and -7, G-5, -6 and -7, and I-9. Water is supplied to all F and G sectors from Simly Filtration Plant and other head works. In Sector I-9, water is supplied from tubewells installed within the sector and a distribution main of ϕ18" pipe is connected from the reservoir on Shakerperian Hill (running from the New Golf Course Head Works under construction) to this sector (I-9). See Fig. 3.1-2.

The laying conditions of the existing distribution pipelines were inspected by the Team, whereas details of brach pipes were not surveyed. The total length of the existing main pipeline is 52.8 miles (84.6 km) and PRCC pipes are usually used for ϕ12" or larger size while cast iron pipes are used for ϕ10" or smaller size. Table 3.1-10 shows these pipes by sizes.

Table 3.1-10

| Diameter of Pipe | Length of Pipe |
|---|---|
| 18" diameter PRCCP | 25,400 m |
| 15" diameter PRCCP | 13,600 m |
| 12" diameter PRCCP | 22,100 m |
| 10" diameter CIP | 5,200 m |
| 9" diameter CIP | 13,700 m |
| 8" diameter CIP | 1,440 m |
| 6" diameter CIP | 1,620 m |
| 4" diameter CIP | 850 m |
| Total | 84,575 m (52.8 miles) |

The condition of distribution mains is as follows:

1) Normally, the pipes laid under main streets are of twin line system. Most distribution pipes are laid under public roads and some small diameter distribution pipes are laid under private gardens, green spaces, etc.

2) There are some pipelines exposed to open air or laid to a greater depth than necessary as the result of improper planning and/or installation works. These have brought about difficulties in maintenance and sometimes caused water leakage.

3) The networks of distribution pipes are rather complicated. Many and complicated branch pipes are installed at crossing points to connect pipes from various head works in the network. Lots of valves have been installed accordingly and difficulties are always encountered to operate and maintain these valves. An example of such complicated network is shown in Fig. 3.1-2.

   Since the raw water main pipe coming from G-10 Head Works is cross-connected to the distribution main of 18" in diameter in Sector F-6, wrong operation of the valves can make raw water from the raw water main run into the distribution pipe. It is a common practice to avoid connection of pipe lines having different water quality, such as between clear water pipe and raw water pipe.

4) Almost all of the valves used do not operate satisfactorily because of the defective gland structure. Practically, these valves are useless. Therefore, it is necessary to improve distribution pipe networks so that their maintenance and control may be easily done and to always check valves, etc. so as to be operative whenever required.

5) Two types of pipes, CIP and PRCC, are currently used. The latter is used for pipes whose size ranges from 12" to 18" (relatively large diameters), while most of the pipes whose size is less than 12" are CIP. Jointing is made by rubber rings for PRCC and by lead rings for CIP.

   Generally, PRCC pipes are not employed for water distribution purposes because they are not easily connected with a service pipe. The reason why PRCC pipes have been used for water distribution in Islamabad is because 12" or larger size of CIP cannot be obtained locally (imported ones are used whenever required) but PRCC pipes can be manufactured locally for sizes of up to 36".

   Despite the fact, however, CIP or DCIP should replace the current PRCC in future to meet the requirements of distribution pipe.

6) According to the results the Japan Survey Team obtained at several strategic points, the average water supply pressure in the distribution networks is in the range of 0.5-0.6 $kg/cm^2$ (7-8.6 psi) with a maximum of 1.0 $kg/cm^2$ (14 psi). These values are rather low for water supply. Such low water pressure may be attributable to the facts that there are no reservoirs which meet requirements for all the locations, capacities and water pressure, that the distribution networks have not yet been completed, and basically, that water sources available are not sufficient for the demand resulting in chronic shortage of water.

c) House Connection

Two systems are used for house connection. One is to supply water directly from the distribution pipe to each house, the other is to supply water to each house after it is stored temporarily in under ground tanks and pumped up to overhead tanks.

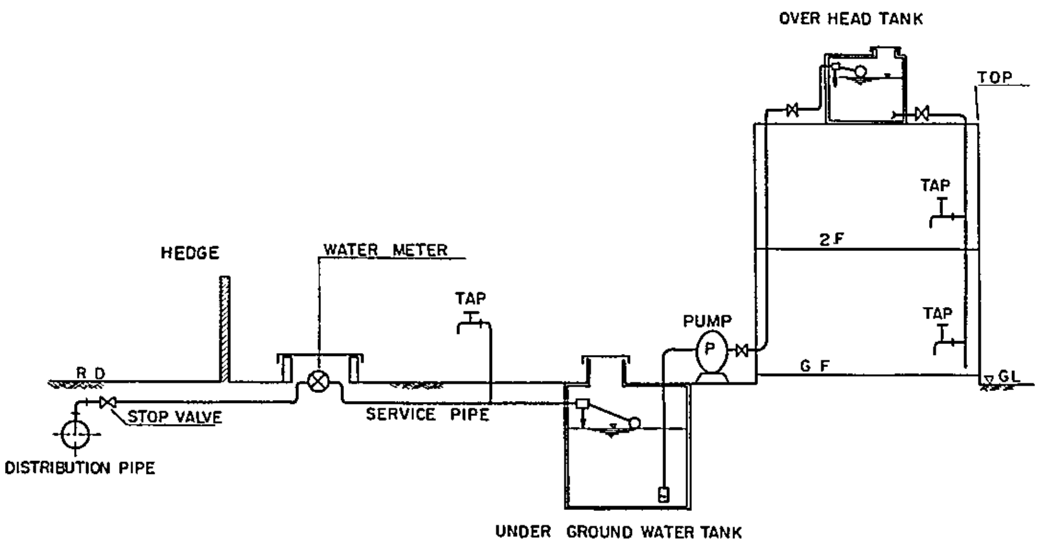
The latter is most popularly used as the standard installation of water service to residence in Islamabad. Detail of this installation is shown in Fig. 3.1-14.

d) Underground Tank

Water branched from the distribution pipe is metered and stored in the underground tank. Then water is pumped from this tank up to the overhead tank installed on the roof of the house and supplied by gravity flow. The volume of the over head tank is about 350 cu.ft. (10 $m^3$), which is almost identical with that of the underground tank.

In Islamabad, there is the regulation of house planning that each house should have an overhead tank on the roof. The underground tank may be useful for more or less easing the current 'chronic' water shortage. However, contamination of the tank from outside owing to its defective structure and/or incomplete installation is observed and, as a result, the water quality of the tank is exposed to danger. If such underground tanks are indispensable, some improvement measure should be taken to prevent water pollution.

FIG 3.1-14 STANDARD INSTALLATION OF HOUSE CONNECTION FOR RESIDENCE



## 3.2 Water Production and Use

### 3.2.1 Water Production

The existing water sources are as follows:

(a) Surface water

| Situation of Head Works | | Capacity | Water Level | Year of Completion |
|---|---|---|---|---|
| 1. | Saidpur | 0.7 mgd | 2,043 ft | 1963 |
| 2. | Nurpur | 0.7 | 2,073 | 1963 |
| 3. | Golf course | 2.5 | 1,725 | 1966 |
| 4. | G-10 | 2.0 | 1,730 | 1966 |
| 5. | Korang | 2.4 | 1,825 | 1966 |
| 6. | Shahdra | 1.6 | 2,130 | 1967 |
| 7. | Simly | 5.0 | 2,185 | 1965 |
| | Total | 14.9 | | |

(b) Underground water

| Situation of Tube Well | | Capacity | Water Level | Year of Exploring |
|---|---|---|---|---|
| 1. | G-9 | 0.25 mgd | 1,410 ft | 1962-63 |
| 2. | G-7/2 | 0.25 | 1,450 | 1962-63 |
| 3. | F-8 | 0.20 | 1,740 | 1968 |
| 4. | G-5 | 0.15 | 1,730 | 1963 |
| 5. | I-9 (2 wells) | 0.6 each | 1,400 | 1969-70 |
| 6. | Administrative sector | (0.5) | 1,910 | 1962-63 (abandoned in 1965) |
| 7. | G-7/2 (3 shallow wells) | 0.2 each | 1,470 | 1969-70 (one well now under construction) |
| | Total | 2.65 | | |

Tube wells at Sector I-9 are supplying water only industrial zone there. Sector I-9 is designated as the light industrial zone, and steel rolling mill, reinforced concrete pipe factory, ice factory, flour mill, seven-up factory, oil storage ... etc. They are in operation or are now under construction. The normal resident houses are not found there.

The development at Sector G-7 is in full progress at present and the deep well at G-7/2 is supplying water for the new resident houses there.

Other three numbers of shallow wells at G-7/2 are supplying water for the construction of new houses without chlorination.

The deep well at Administrative Sector was abandoned since 1965 due to drop of water level. Consequently, only those wells at G-9, F-8, G-5 are supplying potable water for the public. Following Table 3.2-1 and Fig. 3.2-1 are the data of water production at different water sources, prepared by Directorate of Water and Sewerage, CDA.

Table 3.2-1

Monthly Discharge of Water from Different Sources in Islamabad in 1965

Unit: Mgd

| S. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sources / Month | Saidpure | Nurpur | Golf Course | G-10 | Korang | Shah-dra | Simly | G-7/2 Tube Well | Total | I-9 Tube Well |
| Jan. | 0.8 | 0.6 | - | - | - | - | - | 0.05 | 1.45 | 0.13 |
| Feb. | 0.8 | 0.6 | - | - | - | - | - | 0.05 | 1.45 | 0.13 |
| March | 0.8 | 0.6 | - | - | - | - | - | 0.05 | 1.45 | 0.13 |
| April | 0.7 | 0.4 | - | - | - | - | - | 0.05 | 1.15 | 0.13 |
| May | 0.6 | 0.4 | - | 2.0 | - | - | - | 0.05 | 3.05 | 0.12 |
| June | 0.4 | 0.3 | - | 1.5 | - | - | - | 0.05 | 2.25 | 0.10 |
| July | 0.5 | 0.5 | - | 1.5 | - | - | - | 0.05 | 2.55 | 0.10 |
| Aug. | 0.8 | 0.5 | - | 1.8 | - | - | - | 0.04 | 3.14 | 0.12 |
| Sept. | 0.8 | 0.5 | - | 2.0 | - | - | - | 0.04 | 3.34 | 0.13 |
| Oct. | 0.8 | 0.6 | - | 2.0 | - | - | - | 0.05 | 3.45 | 0.13 |
| Nov. | 0.8 | 0.6 | - | 2.0 | - | - | - | 0.05 | 3.45 | 0.13 |
| Dec. | 0.8 | 0.6 | - | 2.0 | - | - | - | 0.05 | 3.45 | 0.13 |
| Total | 8.6 | 6.2 | - | 14.8 | - | - | - | 0.58 | 30.18 | 1.48 |
| Average | 0.72 | 0.52 | - | 1.85 | - | - | - | 0.05 | 3.14 | |

Monthly Discharge of Water
from Different Sources in Islamabad
in 1966

Unit: mgd

| S. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sources / Month | Said-pure | Nurpur | Golf Course | G-10 | Korang | Shah-dra | Simly | G-7/2 Tube Well | Total | I-9 Tube Well |
| Jan. | 0.8 | 0.6 | - | 2.0 | - | - | - | 0.05 | 3.45 | 0.13 |
| Feb. | 0.8 | 0.6 | - | 2.0 | - | - | - | 0.05 | 3.45 | 0.13 |
| March | 0.8 | 0.6 | - | 2.0 | - | - | - | 0.05 | 3.45 | 0.13 |
| April | 0.7 | 0.4 | - | 2.0 | - | - | - | 0.05 | 3.15 | 0.13 |
| May | 0.6 | 0.3 | - | 2.0 | - | - | - | 0.06 | 2.96 | 0.10 |
| June | 0.5 | 0.3 | 1.50 | 2.0 | - | - | - | 0.05 | 4.35 | 0.10 |
| July | 0.7 | 0.4 | 1.50 | 2.0 | - | - | - | 0.05 | 4.65 | 0.13 |
| Aug. | 0.8 | 0.5 | 1.70 | 2.0 | - | - | - | 0.06 | 5.06 | 0.13 |
| Sept. | 0.8 | 0.5 | 1.80 | 2.0 | - | - | - | 0.07 | 5.17 | 0.14 |
| Oct. | 0.8 | 0.6 | 2.0 | 2.0 | - | - | - | 0.07 | 5.47 | 0.14 |
| Nov. | 0.8 | 0.6 | 2.0 | 2.0 | - | - | - | 0.07 | 5.47 | 0.14 |
| Dec. | 0.8 | 0.6 | 2.0 | 2.0 | 1.4 | - | - | 0.07 | 6.87 | 0.14 |
| Total | 8.90 | 6.0 | 12.5 | 24.0 | 1.4 | - | - | 0.70 | 53.50 | |
| Average | 0.74 | 0.50 | 1.79 | 2.0 | 1.4 | - | - | 0.06 | 6.49 | |

Monthly Discharge of Water
from Different Sources in Islamabad
in 1967

Unit: mgd

| S. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sources / Month | Said-pure | Nurpur | Golf Course | G-10 | Korang | Shah-dra | Simly | G-7/2 Tube Well | Total | I-9 Tube Well |
| Jan. | 0.8 | 0.6 | 1.71 | 2.0 | 1.4 | - | - | 0.07 | 6.58 | 0.14 |
| Feb. | 0.8 | 0.6 | 1.63 | 2.0 | 1.3 | - | - | 0.07 | 6.40 | 0.07 |
| March | 0.8 | 0.5 | 1.63 | 2.0 | 1.5 | - | - | 0.05 | 6.48 | 0.10 |
| April | 0.6 | 0.4 | 2.2 | 1.8 | 1.1 | 1.0 | - | 0.05 | 7.15 | 0.10 |
| May | 0.6 | 0.4 | 1.56 | 1.6 | 2.0 | 0.8 | - | 0.04 | 7.00 | 0.11 |
| June | 0.4 | 0.3 | 1.70 | 1.5 | 1.5 | 0.6 | - | 0.02 | 6.02 | 0.15 |
| July | 0.6 | 0.3 | 1.90 | 1.5 | 1.6 | 0.6 | - | 0.07 | 6.57 | 0.14 |
| Aug. | 0.8 | 0.3 | 1.90 | 1.8 | 1.6 | 0.8 | - | 0.04 | 7.24 | 0.14 |
| Sept. | 0.8 | 0.4 | 1.90 | 2.0 | 1.6 | 1.0 | - | 0.04 | 7.74 | 0.18 |
| Oct. | 0.8 | 0.5 | 1.90 | 2.0 | 1.6 | 1.2 | - | 0.05 | 8.05 | 0.13 |
| Nov. | 0.8 | 0.6 | 1.90 | 2.0 | 2.0 | 1.4 | - | 0.05 | 8.75 | 0.13 |
| Dec. | 0.8 | 0.6 | 1.90 | 2.0 | 1.8 | 1.6 | - | 0.06 | 8.76 | 0.13 |
| Total | 8.6 | 5.5 | 21.83 | 22.2 | 19.0 | 9.0 | - | 0.61 | 86.74 | |
| Average | 0.72 | 0.46 | 1.82 | 1.85 | 1.58 | 1.0 | - | 0.05 | 7.48 | |

### Monthly Discharge of Water from Different Sources in Islamabad in 1968

Unit: mgd

| S. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sources / Month | Said-pure | Nurpur | Golf Course | G-10 | Korang | Shah-dra | Simly | G-7/2 Tube Well | Total | I-9 Tube Well |
| Jan. | 0.8 | 0.6 | 1.9 | 2.0 | 1.8 | 1.6 | - | 0.06 | 8.76 | 0.13 |
| Feb. | 0.8 | 0.6 | 1.9 | 2.0 | 1.9 | 1.6 | - | 0.06 | 8.86 | 0.13 |
| March | 0.8 | 0.6 | 1.9 | 2.0 | 2.0 | 1.4 | - | 0.06 | 8.76 | 0.13 |
| April | 0.6 | 0.4 | 1.8 | 2.0 | 1.6 | 1.2 | - | 0.06 | 7.66 | 0.13 |
| May | 0.6 | 0.3 | 1.6 | 1.6 | 0.8 | 0.6 | - | 0.04 | 5.54 | 0.13 |
| June | 0.4 | 0.3 | 1.6 | 1.5 | 0.5 | 0.4 | - | 0.02 | 4.72 | 0.13 |
| July | 0.6 | 0.5 | 1.6 | 1.6 | 1.0 | 0.6 | - | 0.04 | 5.94 | 0.13 |
| Aug. | 0.8 | 0.5 | 1.6 | 1.8 | 2.0 | 0.8 | - | 0.04 | 7.54 | 0.13 |
| Sept. | 0.8 | 0.5 | 1.8 | 2.0 | 2.0 | 1.2 | - | 0.04 | 8.34 | 0.13 |
| Oct. | 0.8 | 0.6 | 1.8 | 2.0 | 2.0 | 1.4 | - | 0.04 | 8.64 | 0.14 |
| Nov. | 0.8 | 0.6 | 1.8 | 2.0 | 2.0 | 1.6 | - | 0.04 | 8.84 | 0.14 |
| Dec. | 0.8 | 0.6 | 1.8 | 2.0 | 2.0 | 1.5 | - | 0.04 | 8.74 | 0.14 |
| Total | 8.60 | 6.10 | 21.10 | 22.50 | 19.60 | 13.90 | | 0.54 | 92.34 | |
| Average | 0.71 | 0.51 | 1.76 | 1.88 | 1.63 | 1.16 | | 0.045 | 7.70 | |

### Monthly Discharge of Water from Different Sources in Islamabad in 1969

Unit: mgd

| S. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sources / Month | Said-pure | Nurpur | Golf Course | G-10 | Korang | Shah-dra | Simly | G-7/2 Tube Well | Total | I-9 Tube Well |
| Jan. | 0.8 | 0.6 | 1.8 | 2.0 | 2.0 | 1.4 | - | 0.04 | 8.64 | 0.15 |
| Feb. | 0.8 | 0.6 | 1.8 | 2.0 | 2.0 | 1.4 | - | 0.04 | 8.64 | 0.15 |
| March | 0.8 | 0.6 | 1.6 | 2.0 | 2.0 | 1.2 | - | 0.04 | 8.24 | 0.15 |
| April | 0.6 | 0.4 | 1.4 | 1.8 | 1.5 | 1.0 | 2.0 | 0.04 | 8.74 | 0.14 |
| May | 0.5 | 0.3 | 1.2 | 1.5 | 1.2 | 0.8 | 1.2 | 0.04 | 6.74 | 0.13 |
| June | 0.4 | 0.2 | 1.0 | 1.2 | 0.5 | 0.4 | 0.5 | 0.04 | 4.24 | 0.13 |
| July | 0.6 | 0.4 | 2.0 | 1.5 | 1.2 | 1.6 | 1.0 | 0.02 | 8.32 | 0.14 |
| Aug. | 0.6 | 0.6 | 2.0 | 1.8 | 2.0 | 1.0 | 2.0 | 0.04 | 10.04 | 0.14 |
| Sept. | 0.7 | 0.6 | 2.0 | 2.0 | 2.0 | 1.2 | 2.5 | 0.04 | 11.04 | 0.14 |
| Oct. | 0.7 | 0.6 | 2.0 | 2.0 | 2.0 | 1.4 | 2.5 | 0.04 | 11.24 | 0.14 |
| Nov. | - | - | - | - | - | - | - | - | - | - |
| Dec. | - | - | - | - | - | - | - | - | - | - |
| Total | 6.50 | 4.90 | 16.80 | 17.80 | 16.40 | 11.40 | 11.70 | 0.380 | 85.88 | |
| Average | 0.65 | 0.49 | 1.68 | 1.78 | 1.64 | 1.14 | 1.67 | 0.04 | 9.09 | |

At Saidpur and Nurpure Head Works water meters are not provided on the transmission mains but a triangular weir is installed at the end of raw water line, although its metering record is not accurate.

At Golf Course, G-10, Korang and Shahdra Head works, Waltman type water meters are provided at the beginning point of transmission mains. Those meters are working almost in good conditions.

Waltman type water meters which are installed at delivery pipe of tube wells are almost out of order and not functioning.

At Simly Filtration Plant, venturi tubes are installed on the raw water main and pipe gallery of rapid sand filters, and a flow rate is recorded on the control panel.

Following Table 3.2-2 shows the difference between the monthly discharge calculated from the record of daily discharge at Korang Head Work and Simly Filtration Plant, and data furnished by CDA. Table 3.2-3 shows the monthly discharge of each head works in 1969. All the figures of monthly discharge were obtained by applying the curve of monthly discharge of Korang and Simly to other head works.

Table 3.2-2

Monthly Discharge of Water from Korang Head Works and Simly Filtration Plant in 1969

| Korang Head Works | | | | Simly Filtration Plant | | | |
|---|---|---|---|---|---|---|---|
| Month | Data Prepared by CDA | Data Calculated from the Recording Daily Discharge | Difference | Month | Data Prepared by CDA | Data Calculated from the Recording Daily Discharge | Difference |
| Jan. | 2.0 | 2.32 | -0.32 | Jan. | - | - | |
| Feb. | 2.0 | 2.23 | -0.23 | Feb. | - | - | |
| March | 2.0 | 2.21 | -0.21 | March | - | - | |
| April | 1.5 | 2.26 | -0.76 | April | 2.0 | - | |
| May | 1.2 | 1.85 | -0.65 | May | 1.2 | 2.00 | -0.80 |
| June | 0.5 | 1.35 | -0.85 | June | 0.5 | 1.63 | -1.13 |
| July | 1.2 | 1.87 | -0.67 | July | 1.0 | 1.30 | -0.30 |
| August | 2.0 | 2.61 | -0.61 | August | 2.0 | 2.59 | -0.59 |
| Sept. | 2.0 | 1.35 | +0.05 | Sept. | 2.5 | 4.52 | -2.02 |
| Oct. | 2.0 | 1.80 | +0.20 | Oct. | 2.5 | 3.46 | -0.96 |
| Nov. | | 2.11 | | Nov. | | 2.61 | |
| Dec. | | 2.16 | | Dec. | | 1.45 | |

Table 3.2-3

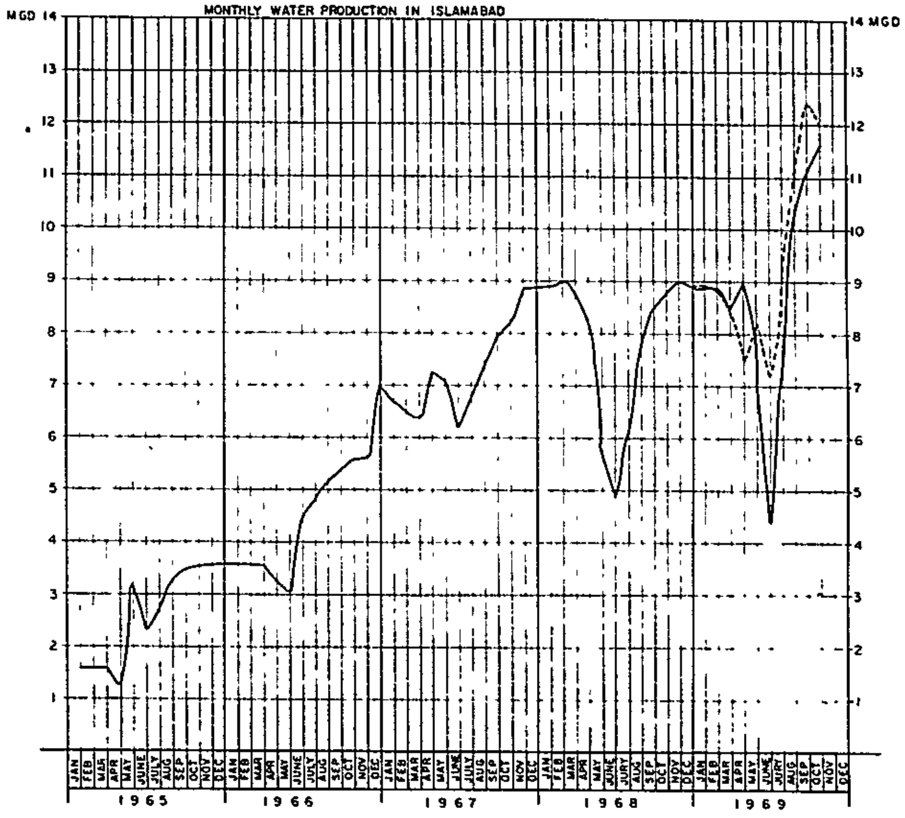
Monthly Discharge of Water from Different Sources in 1969

Unit: mgd

| S. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
|---|---|---|---|---|---|---|---|---|---|
| Sources / Month | Said-pur | Nurpur | Golf Course | G-10 | Korang | Shah-dra | Simly | G-7 Tube Well | Total |
| Jan. | 0.8 | 0.6 | 1.8 | 2.0 | 2.32 | 1.4 | - | 0.04 | 8.96 |
| Feb. | 0.8 | 0.6 | 1.8 | 2.0 | 2.23 | 1.4 | - | 0.04 | 8.87 |
| March | 0.8 | 0.6 | 1.6 | 2.0 | 2.21 | 1.2 | - | 0.04 | 8.45 |
| April | 0.6 | 0.4 | 1.4 | 1.8 | 2.26 | 1.0 | - | 0.04 | 7.50 |
| May | 0.5 | 0.3 | 1.2 | 1.5 | 1.85 | 0.8 | 2.00 | 0.04 | 8.19 |
| June | 0.4 | 0.2 | 1.0 | 1.2 | 1.35 | 0.4 | 1.63 | 0.04 | 7.22 |
| July | 0.6 | 0.4 | 2.0 | 1.5 | 1.87 | 1.6 | 1.30 | 0.02 | 9.29 |
| August | 0.6 | 0.6 | 2.0 | 1.8 | 2.61 | 1.0 | 2.59 | 0.04 | 11.24 |
| Sept. | 0.7 | 0.6 | 2.0 | 2.0 | 1.35 | 1.2 | 4.52 | 0.04 | 12.41 |
| Oct. | 0.7 | 0.6 | 2.0 | 2.0 | 1.80 | 1.4 | 3.46 | 0.04 | 12.00 |
| Nov. | | | | | 2.11 | | 2.61 | | |
| Dec. | | | | | 2.16 | | 1.45 | | |
| Total | | | | | 24.12 | | 19.56 | | |
| Average | 0.65 | 0.49 | 1.68 | 1.78 | | 1.14 | | 0.04 | |

FIG 32-1

MONTHLY WATER PRODUCTION IN ISLAMABAD



### 3.2.2 Water Use

The water mains of distribution system in developed area of Islamabad are shown in Fig. 3.1-2.

Due to the serious water shortage, potable water is being supplied to each sector according to the time schedule showed in Table 3.2-4. Therefore the operation of valves with complicated arrangement is very difficult. The locations of those valves are recorded in Fig. 3.2-2 on the basis information given by CDA staff at the field. It is doubtful if those valves are operated according to the time schedule because of its complicated arrangement.

Based on the climatic condition the maximum day demand should appear in May or June, but it is difficult to know when the maximum day demand occurred from the figures shown in Fig. 3.2-1 "water production in Islamabad" because of water shortage for these years.

It is recognized that the Simly Filtration Plant and Korang Head Works supply the water only to the residential area according to Table 3.2-4.

According to the records of precipitation and temperature from 1875 up to 1965 at Rawalipindi Meteorological Department the minimum average precipitation is 1.25 inches in May and the maximum of mean maximum temperature is 103.7°F in June.

Taking above matters into account maximum day consumption may have occurred in May or June every year. The daily discharge of Simly Plant and Korang Head Works is shown in in Table 3.2-5.

In 1969 maximum day consumption occurred on 2nd of June, as shown in Table 3.2-5. Hourly variation on the same day, from 8 a.m. on 2nd to 8 a.m. on 3rd of June, 1969, are shown in Table 3.2-6 and Fig. 3.2-3 From these data it is pressumed that ratio of maximum hour discharge to average day discharge is 1.22.

Table 3.2-4

Schedule of Water Timing in Islamabad

| S. No. | Source Head Works | Area to be Fed | Timings | Total Hours |
|---|---|---|---|---|
| 1. | Go'f Course | G - 6/4, | 0400 - 0500 | 1 |
| | | G - 6/1 - 4, | 0500 - 0600 | 1 |
| | | G - 6/1 - 2, | 0600 - 0700 | 1 |
| | | G - 6/1, - 6/3 | 0700 - 0800 | 1 |
| | | Office Blocks, Govt. Hostel | 0800 - 1000 | 2 |
| | | G - 6/1 - 2 | 1000 - 1100 | 1 |
| | | G - 6/1 - 3 | 1100 - 1200 | 1 |
| | | Office Blocks, G - 6/4 | 1200 - 1330 | 1 1/2 |
| | | G - 6/1 | 1330 - 1430 | 1 |
| | | G - 6/1 - 4 | 1430 - 1530 | 1 |
| | | G - 6/4 | 1530 - 1700 | 1 1/2 |
| | | G - 6/1 - 2 | 1700 - 1800 | 1 |
| | | G - 6/1 - 3 | 1800 - 1900 | 1 |
| | | G - 6/1 - 4 | 1900 - 2000 | 1 |
| | | G - 6/1, Govt. Hostel | 2000 - 2100 | 1 |
| | | Office Blocks | 2100 - 2300 | 2 |
| 2. | Shahdra | G - 6/1 - 4, D, E and F Type Qrts at G - 6/4 | 0400 - 0800 | 4 |
| | | Hotel Shahrazad | 0800 - 1000 | 2 |
| | | Rusian, French, British and American Embassys | 1000 - 1200 | 2 |
| | | G - 6/1 - 4 | 1200 - 1400 | 2 |
| | | D, E and F Type Qrts at G - 6/4 Hotel Shahrazad | 1400 - 1600 | 2 |
| | | Rusian, French, British and American Embassys | 1600 - 1800 | 2 |
| | | G - 6/1 - 3, Half Portion of G - 6/4 | 1800 - 2100 | 3 |
| | | Hotel Shahrazad | 2100 - 2300 | 2 |
| | | Reserve Tank | 2300 - 2300 | 3 1/2 |
| 3. | Saidpur and G/10 | F - 6/1 and F - 6/2 | 0800 - 1100 | 3 |
| | | F - 7 | 1100 - 1300 | 2 |
| 4. | Simly and Korang | G - 7/1 | 0130 - 0500 | 3 1/2 |
| | | G - 7/3 | 0500 - 0800 | 3 |
| | | F - 6/3, F - 6/4 | 0800 - 1130 | 3 1/2 |
| | | G - 7/4 | 1130 - 1230 | 1 |
| | | G - 7/3 | 1230 - 1930 | 7 |
| | | F - 6/3, F - 6/4 | 1930 - 2330 | 4 |
| | | G - 7/4 | 2330 - 0130 | 2 |
| 5. | Tube Well I-9 & H-9 | | | |
| 6. | Nurpur | Secretariat Buildings | 0000 - 2400 | 24 |
| 7. | Saidpur and G - 10 | G - 6/3 F and G Type Qrts, Poly Clinic | 0400 - 0600 | 2 |
| | | G - 6/2 and E, D Type Qrts | 0600 - 0800 | 2 |
| | | G - 6/2 B and C Type Qrts | 0800 - 0930 | 1 1/2 |
| | | Embassies (private houses), G.P.O. Police station, cinema, shopping centre-V | 0930 - 1230 | 3 |
| | | G - 6/3 F and G Type Qrts, Poly Clinic | 1230 - 1430 | 2 |
| | | All Embassies, Poly Clinic and covered Market | 1430 - 1800 | 3 1/2 |
| | | G - 6/2 and E, D Type Qrts | 1800 - 2000 | 2 |
| | | G - 6/2 B and C Type Qrts | 2000 - 2130 | 1 1/2 |

FIG 3.2-2

VALVE ARRANGEMENT AT THE BEGINNING OF SIMLY CONDUCTION MAIN

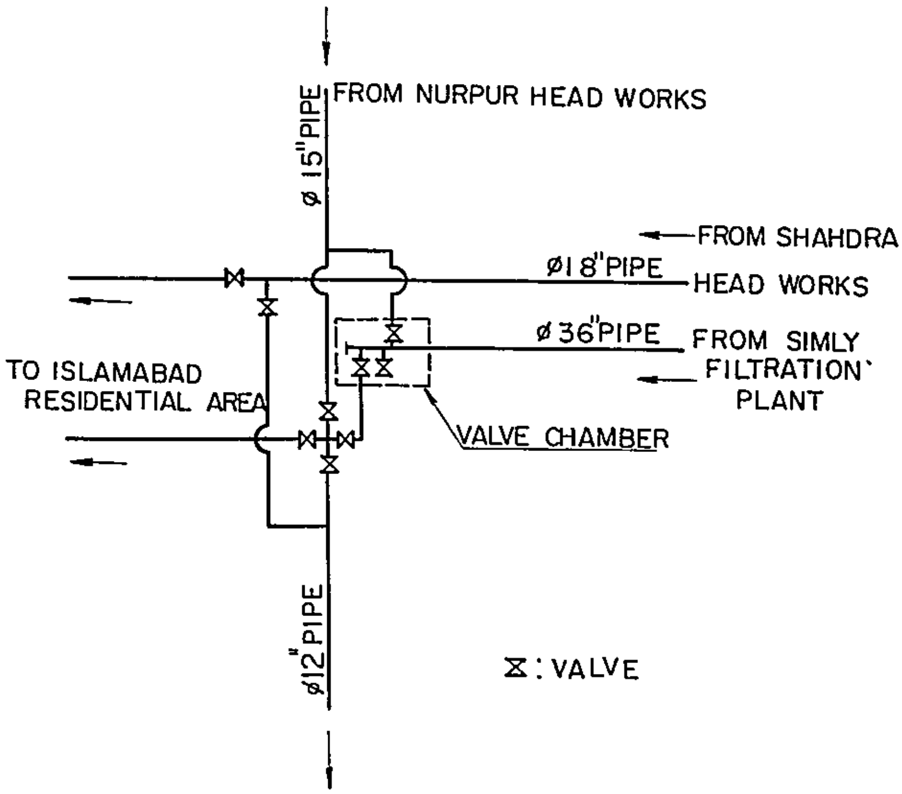


Table 3.2-5

Daily Discharge of Water
For Month of May and June, 1969

Unit: mgd

| May | | | | | June | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Korang | Simly | Total | Remarks | Date | Korang | Simly | Total | Remarks |
| 1 | 2.34 | - | 2.34 | | 1 | 1.437[5] | 1.80 | 3.237 | 5) Electric break down |
| 2 | 2.146 | - | 2.146 | | 2 | 1.712 | 2.80 | 4.512 | |
| 3 | 2.088 | - | 2.088 | | 3 | 1.783 | 2.33 | 4.113 | |
| 4 | 2.316 | - | 2.316 | | 4 | 1.731 | 2.7 | 4.431 | |
| 5 | 2.005 | - | 2.005 | 1) Mixed with simly | 5 | 1.835 | 2.2 | 4.035 | |
| 6 | 1.493[2] | - | 1.493 | | 6 | 1.528 | 1.73 | 3.258 | |
| 7 | 1.844 | 2.0[1] | 3.844 | 2) water shortage | 7 | 1.287 | 2.0 | 3.287 | |
| 8 | 1.381[2] | 2.0 | 3.381 | | 8 | 0.71[6] | 1.47 | 2.18 | 6) Shortage of water at Korang |
| 9 | 1.285[3] | 2.0 | 3.285 | 3) Electric break down | 9 | 0.754 | 1.67 | 2.424 | " |
| 10 | 1.917 | 2.0 | 3.917 | | 10 | 0.515 | 1.47 | 1.985 | |
| 11 | 1.868 | 2.0 | 3.868 | | 11 | 0.707 | 1.50 | 2.207 | |
| 12 | 1.494 | 2.0 | 3.494 | | 12 | 0.59 | 1.36 | 1.95 | |
| 13 | 1.681 | 2.0 | 3.681 | | 13 | 0.513 | 0.90 | 1.413 | |
| 14 | 2.070 | 2.0 | 4.070 | | 14 | 0.907 | 0.97 | 1.877 | |
| 15 | 1.967 | 2.0 | 3.967 | | 15 | 1.109 | 0.93 | 2.039 | |
| 16 | 2.123 | 2.0 | 4.123 | | 16 | 1.146 | 0.87 | 2.016 | |
| 17 | 2.149 | 2.0 | 4.149 | | 17 | 1.008 | 0.98 | 1.988 | |
| 18 | 2.16 | 2.0 | 4.16 | | 18 | 1.275 | 1.10 | 2.375 | |
| 19 | 2.143 | 2.0 | 4.143 | | 19 | 1.696 | 0.47 | 2.166 | |
| 20 | 2.188 | 2.0 | 4.188 | | 20 | 2.375 | - | 2.375 | |
| 21 | 2.063 | 2.0 | 4.063 | | 21 | 2.21 | - | 2.21 | |
| 22 | 2.073 | 2.0 | 4.073 | | 22 | 1.808 | 1.90 | 3.708 | |
| 23 | 2.116 | 2.0 | 4.116 | | 23 | 1.588 | 2.20 | 3.788 | |
| 24 | 1.978 | 2.0 | 3.778 | | 24 | 0.694[7] | 2.30 | 2.994 | 7) Pump connection |
| 25 | 1.671 | 2.0 | 3.671 | | 25 | 2.00 | 2.24 | 4.24 | |
| 26 | 1.831 | 2.0 | 3.831 | | 26 | 2.085 | 1.98 | 4.065 | |
| 27 | 1.741 | 2.0 | 3.741 | | 27 | 1.699 | 1.48 | 3.179 | |
| 28 | 1.637 | 2.0 | 3.637 | | 28 | 1.419 | 1.31 | 2.729 | |
| 29 | 1.361 | 2.0 | 3.361 | | 29 | 1.068 | 1.20 | 2.268 | |
| 30 | 1.341 | 2.0 | 3.349 | | 30 | 1.174 | 1.70 | 2.874 | |
| 31 | 1.009[4] | 2.0 | 3.009 | 4) Electric break down | | | | | |
| | 57.469 | | | | | 40.425 | | | |

Table 3.2-6

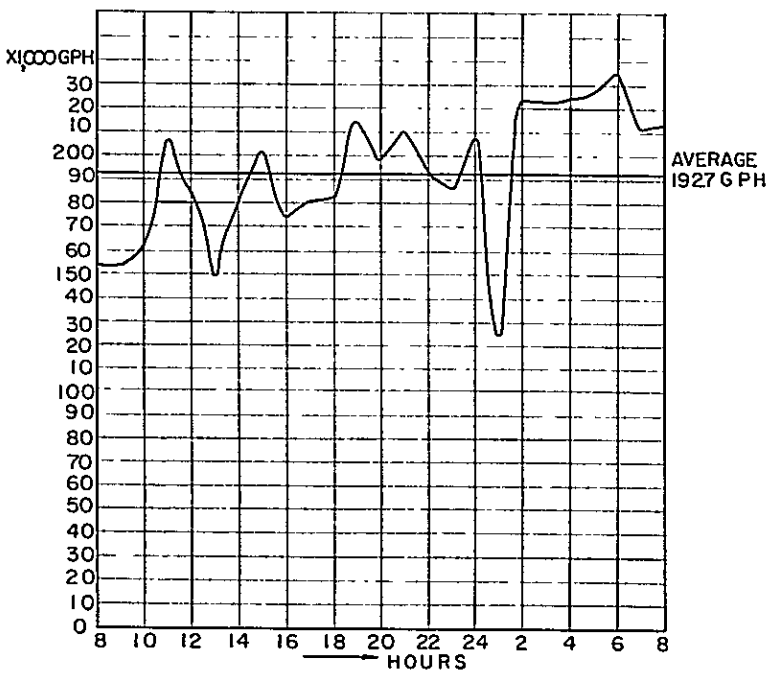
Hourly Discharge of Water
At Korang Head Works
and
Simly Filtration Plant
on 2nd of June, 1969

x 1,000 gph

| Time | Korang | Simly | Total |
|---|---|---|---|
| 8 a.m. | 41 | 112.5 | 153.5 |
| 9 | 41 | 112.5 | 153.5 |
| 10 | 41 | 112.5 | 161.5 |
| 11 | 93 | 112.5 | 205.5 |
| 12 | 73 | 112.5 | 185.5 |
| 13 | 37 | 112.5 | 149.5 |
| 14 | 66 | 112.5 | 178.5 |
| 15 | 88.5 | 112.5 | 201 |
| 16 | 61 | 112.5 | 173.5 |
| 17 | 68 | 112.5 | 180.5 |
| 18 | 70 | 112.5 | 182.5 |
| 19 | 102 | 112.5 | 214.5 |
| 20 | 86 | 112.5 | 198.5 |
| 21 | 98 | 112.5 | 210.5 |
| 22 | 81 | 112.5 | 193.5 |
| 23 | 74 | 112.5 | 186.5 |
| 24 | 82 | 125 | 207 |
| 1 | 0 | 125 | 125 |
| 2 | 98 | 125 | 223 |
| 3 | 98 | 125 | 223 |
| 4 | 99 | 125 | 224 |
| 5 | 101 | 125 | 226 |
| 6 | 110 | 125 | 235 |
| 7 | 87 | 125 | 212 |
| 8 | 88 | 125 | 213 |

FIG 32-3

HOURLY DISCHARGE OF WATER AT KORANG HEAD WORKS AND SIMLY FILTRATION PLANT ON 2ND OF JUNE, 1969



Overhead Tank

By the Schedule 4 of the Islamabad Residential Sectors Zoning Regulation, it is prescribed that an overhead tank of adequate capacity should be provided to each house. Existing houses, excluding one part of Type D and E, have been mostly equipped with overhead tanks.

Moreover, as the pressure at the end of water pipe is very low, each private house has an overhead tank to avoid water suspension. The quantities of water sources are absolutely insufficient.

Considering above, it is impossible to estimate from the data provided by CDA the average day, maximum day and maximum hour demand respectively which are necessary for making future plan.

3.2.3 Water Meter

About 40,000 numbers of water meter for house use have been imported from Poland and kept in CDA stockyard.

Table 3.2-7 shows the present condition of water meters equipped at houses as of Feb., 1970. The Japan Survey Team selected and tested 60 numbers of meters at random out of 9,738 numbers of installed meters. It was found that 33 numbers, almost 50% of tested meters, are out of order, such as leakage, broken glass, etc. Only 27 are operating in good condition.

Water charges for these 60 connections were charged by fixed rate and not calculated by reading of meters.

The Team estimated the water consumption per month of 27 connections by reading in two weeks between March 30 and April 13, and compared it with the figure calculated by CDA water rate standard. The latter 93,400 gallons per month was 11% more than the former 83,913 gallons per month.

Considering the climatic condition, the daily consumption in early April may be assumed to be the average day consumption. In any case, it is essential to provide water meter in each house and charge by reading water meter.

Table 3.2-7

Numbers of Metered
Service Connections

| Class of Water User | Metered | Non Metered | Total |
|---|---|---|---|
| 1. Domestic | 9,738 NOS | 110 NOS | 9,848 NOS |
| 2. Commercial | 60 NOS | 300 NOS | 360 NOS |
| 3. Public Fountains of taps | 80 NOS | 50 NOS | 130 NOS |
| 4. Government (Free) | - | 70 NOS | 70 NOS |
| 5. Construction Purposes | 370 NOS | - | 370 NOS |
| Total | 10,248 NOS | 530 NOS | 10,778 NOS |

## 3.3 Water Charges

### 3.3.1 Rate and Billing

The rate structure and billing system of CDA is legally fixed, but in fact all the processes of meter reading and billing are not thoroughly followed in accordance with the established rules. An outline of the present situation of this affair is described as under.

The Boad of CDA, comprised of 1) Chairman, 2) Member Financial Adviser, 3) Member Administration; 4) Member Technical, established a committee to review financing problems of water supply in Islamabad with the following members:

1. Deputy Financial Adviser - Chairman
2. Director Municipal Administration - Member
3. Director Maintenance - Member

The summary of recommendations submitted to the Board by the Water Committee on July, 1969, is as follows:

1. Water supply in Islamabad should be metered.

2. The work of connections, meters installitions and

their repair/replacement for all the sectors in Islamabad should be the responsibility of Director Maintenance.

3. Meters should be sealed and placed under locked chambers at the time of granting connections.

4. Water meters readings and recovery of charges should be the responsibility of the Director Municipal Administration.

5. Water Bye-Laws already submitted by the Director Municipal Administration, should be finalized expeditiously.

6. Water charges should be recovered at the rates as stipulated in ANNEX-1.

Recoveries of water charges for the period from July, 1966 to June, 1967 were made by the Maintenance Directorate.

The water meter readings, billing and recoveries of water charges from July, 1967 has been continued to be done by Directorate of Municipal Administration. The running and maintenance of water meter is the responsibility of Directorate Maintenance. The work of connection and meter installation are also done by Directorate Maintenance.

Handing/taking over of water meters installed was not done, hence, maintenance of water meters after the installation was not carried out.

The handling of water meter is complicated and upto now even one meter reading was not carried out and the water charge is covered by only the flat rate.

By the Board decision in August of 1969, not only maintenance of water meters but also meter reading will henceforth be done by the Maintenance Directorate.

The Directorate of Municipal Administration is responsible for billings. The water bill is mailed to consumers every 6 months and the money is deposited in the Bank by consumers.

In accordance with the CDA Board decision, the staff of meter readers and clerks were transferred from the Administration Directorate to the Maintenance Directorate.

According to the record of Administration Directorate, the current figures of the income of water charges is as follows:

| Financial Year | Amount | Remarks |
|---|---|---|
| 1966 - 67 | Rs. 2,851 | Areas for 1965 - 66 |
| 1967 - 68 | Rs.207,898 | |
| 1968 - 69 | Rs.409,356 | |
| 1969 - 70 | Rs.427,981 | $285,281 \times \frac{12 \text{ month}}{8 \text{ month}}$ |

Water charge for private houses where water meters are equipped, is calculated by Water Charge Ordinance of CDA at the rate of Rs. 1 per 1,000 gallons. The actual income of supplied water is only 10 percent or less of the total water charges calculated on the bases of Water Bye-Laws as shown in the following table.

| Year | Annual Production (Mg) | Annual Revenue as Water Charge (Rs) | Calculated Water Charge Rs. per 1,000 Gallons |
|---|---|---|---|
| 1966 | 2,369 | 2,851 | 0.0012 |
| 1967 | 2,723 | 207,898 | 0.008 |
| 1968 | 2,803 | 409,356 | 0.15 |
| 1969 | 3,309 | 427,931 | 0.13 |

3.3.2 Housing and Its Regulation

As described in the foregoing section, rate and billing is stipulated in details in ANNEX-1.

According to this regulation, the rate is fixed mainly on the basis of the classifications of houses, so that two regulations which have connections with the classifications are attached in ANNEX's-2 and 3.

The details of the Government Officer's houses constructed by CDA are shown in Table 3.3-1.

The details of private houses on the land sold to the public by CDA are shown in Table 3.3-2.

Table 3.3-1

Houses for Government Officers

| Type of House | Plot Size Sq. Yds | Plinth Area Sq. Ft. | Accommodation | Increase Group | House Rent/ Year | Officers to Entitle |
|---|---|---|---|---|---|---|
| A | 125 | 330 | 2-Rooms, Kitchen, Verandah Bath & W.C. | Upto Rs 10 | - | Class IV |
| B | 162 | 450 | " | Rs 110-229 | - | " |
| C | 200 | 108 | 3-Rooms, Kitchen, Verandah, Bath & W.C. | Rs 230-384 | - | Class III |
| D | 250 | 930 | 1-Drawing, 1-Dining, 2-Bed Rooms W.C. Bath, Verandah, Kitchen and Store | Rs 385-474 | - | " |
| E | 500 | 1,150 | 1-Drawing, 1-Dining, 2-Bed Rooms, 2 Baths, Verandah, Kitchen & Servant Quarters | Rs 475-749 | Rs 450 | Class II Officers |
| F | 1,000 | 2,300 | 1-Drawing, 1-Dining, 1-Guest, 2 Beds, 2 Baths, Kitchen, Stores, Verandah, Servant Qr. and a Garage | Rs 750-1249 | Rs 750 | Section Officers |
| G | 1,000 | 2,650 | 1-Drawing, 1-Dining, 1-Guest, 2 Beds, 2 Baths, Kitchen, Stores, Pantry, Verandah, 2 Servant Qrs & a Garage | Rs 1250-1699 | Rs 1000 | Selection Gde & Dg Secretaries |
| H | 2,000 | 2,750 | 1-Drawing, 1-Dining, 2-Beds, 1-Guest, 3 Baths, Kitchen, Pantry, Stores, Verandah, 2-Servant Qrs. & a Garage | Rs 1700-2499 | Rs 1200 | Sr. Deputy Secretaries |
| I | 2,500 | 3,550 | 1-Drawing, 1-Dining, 3-Beds, 1-Guest, 4-Baths, Kitchen, Stores, Pantry, Verandah, 3-Servant Qrs. and a Garage | Rs 2500-2749 | Rs 1600 | Joint Secretaries |
| K | 3,000 | 4,050 | 1-Drawing, 1-Dining, 3-Beds, 1-Guest, 1-Study, 4-Baths, Kitchen, Pantry, Verandah, Store, 3-Servant Qrs. & a Garage | Rs 2750 and above | Rs 2500 | Officers Drawing Rs 2750 and above |

Table 3.3-2

Private Houses

| Type of House | Plot Size Sq. Yds | Built up Area Sq. Ft | Accommodation |
|---|---|---|---|
| E | 300 | 1,560 | 1-Drawing, 1-Dining, 2-Bed Rooms, 2-Baths Verandah, Kitchen and Servant Quarters |
| F | 450 | 2,150 | 1-Drawing, 1-Dining, 1-Guest, 2-Bed Rooms 2-Baths, Kitchen, Stores, Verandah, Servant Quarters and a Garage |
| G | 600 | 2,300 | 1-Drawing, 1-Dining, 1-Guest, 2-Beds, 2-Baths, Kitchen, Stores, Pantry, Verandah, 2-Servant Quarters and a Garage |
| H | 750 | 3,150 | 1-Drawing, 1-Dining, 2-Beds, 1-Guest, 3-Baths, Kitchen, Pantry, Stores, Verandah, 2-Servant Quarters and a Garage |
| I | 905 | 3,580 | 1-Drawing, 1-Dining, 3-Beds, 1-Guest, 4 Baths, Kitchen, Stores, Pantry, Verandah, 3-Servant Quarters and a Garage |

## 3.4 The Existing Water Meters

As explained in details in 3.2.2, about 50% of installed meters are out of order.

To locate the cause of such faulty meters, The Team brought back two sets of 3/4" diameter water meters accounting for the greater part of the total imported ones. One is a new meter in stock and the other is a used meter which was actually working before our removing it.

In Japan, both the new and used water meters were analyzed to find defect at K.K. Kimmon Saisakusho, a water meter manufacturer of this country.

These meters were checked for their flow to make a comparison in accuracy. Reading errors found with each test meter are shown in Table 3.4-1.

While the new water meter was found normal, the used meter showed a fairly slow motion compared with the motion for large flow, and suddenly stopped running when the discharge decreased to 22 gallons per hour or less. Both the meters were then disassembled and checked to find out the cause, while comparing one with the other.

Table 3.4-1

| Discharge Gallon per Hour | Errors (percentage) | |
|---|---|---|
| | New Water Water | Used Water Meter |
| 1437 | - 0.6 | -19.4 |
| 647 | - 1.8 | -19.6 |
| 452 | - 2.2 | -19.7 |
| 221 | - 2.2 | -20.7 |
| 134 | + 0.4 | -18.5 |
| 90 | + 0.9 | -20.0 |
| 44 | + 1.8 | -23.2 |
| 33 | + 3.0 | -24.2 |
| 22 | + 3.0 | -56.0 |
| 17.6 | - 1.0 | No run |
| 11 | -10.2 | No run |
| 6.6 | -29.7 | No run |
| 4.4 | -55.7 | No. run |

- Water quality:

The strainer installed at the inlet of the meter is clogged with fibrous jute over the entire surface, resulting in a reduced effective area of the strainer. This causes the loss head to be large during water flow. In the worst case, only a very small quantity of water will be permitted to flow out of the strainer if the water tap is opened.

The fibrous jute in question may have come in when a new water pipe was connected. Should the material be always apt to come in with the distribution pipe, it is necessary to establish a measure of removing it completely with utmost care at the time of connecting pipes.

Powdery mud in a dry state is found depositing on meter inside walls. It is considered that supplied water might have contained a great quantity of suspended solids.

- Measuring chamber:

The pivot supporting the fan wheel shaft and the vane bearings are not worn out at all. The thrust bearing at the tip of the pinion is worn slightly but this is permissible for continued operation.

- Decelerating gear box:

A few teeth of the pinion of decelerating gear No. 4 are broken, while the counterhole for the gear shaft on the decelerating plate is worn out and enlarged in the aggregate. This has resulted in a reduced accuracy in meter reading.

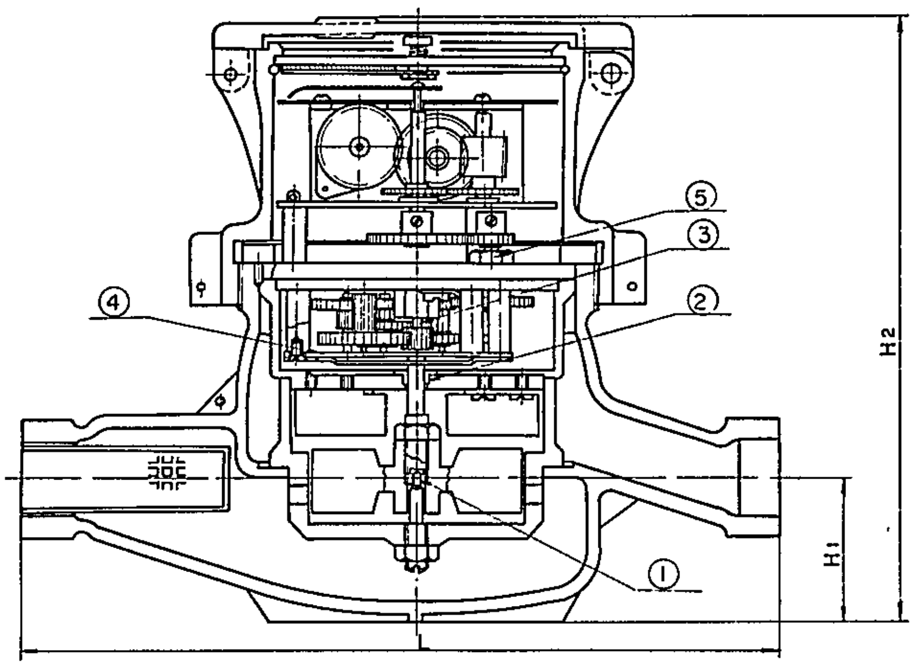
- Register box:

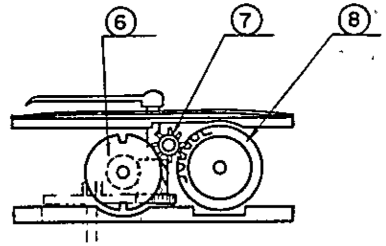
Rotations of the fan wheel which have been decelerated by the decelerating gear chain are transmitted to the gear mechanism in the register box, thus making the pinion drive wheel rotate the number wheel via a pinion. However, the number wheel of the meter under test cannot move smoothly because the two teeth and pinion, both forming the pinion drive wheel, are tightly engaged with each other. This causes a resistance while the meter is running, causing low sensitivity and accuracy of the meter.

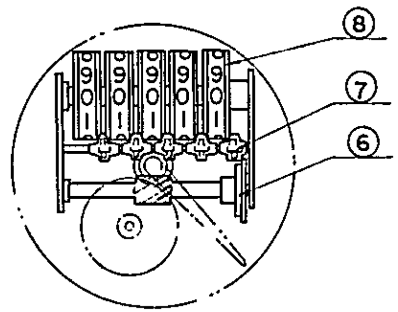
The material itself, of course, involves a problem, but the small tolerance in designing the mechanism has resulted in an insufficient clearance for gear engagement.

It is therefore concluded that such water meters cannot be operated for a long period of time unless they are properly improved.

# FIG 3.4-1 WATER METER




Unit : mm

| Size | Length L | Height H1 | Height H2 | Width (Max.) | Spuds Major Diameter | Spuds Threads per inch |
|---|---|---|---|---|---|---|
| 13 | 170 | 31 | 130 | 100 | 26.4 | 14 |
| 20 | 190 | 33 | 135 | 105 | 33 2 | 11 |
| 25 | 260 | 38 | 140 | 110 | 41.9 | 11 |
| 40 | 300 | 45 | 150 | 110 | 59 6 | 11 |

LEGEND

1. Pivot for the wheel shaft
2. Thrust bearing
3. Fan wheel shaft
4. Decelerating plate
5. Counterhole for the gear shaft
6. Pinion drive wheel
7. Pinion
8. Number wheel

## 3.5 Organization, Personnel and Labours

In order to undertake the huge task of construction of the new capital within a reasonable time an autonomous body, with the necessary legal status and backing, was necessary. The Capital Development Authority Ordinance was, therefore, issued on June 14, 1960 constituting the Authority which is Capital Development Authority, and defining its powers and duties.

The general direction and administration of the Authority, and its affairs, vest in a Board which is required to act on sound principles of development town planning and housing.

As the Capital began to be occupied, the need for municipal services arose. Areas only partially developed came to be occupied. In this transitional stage, it was considered necessary that the municipal functions should also be entrusted to the CDA. The Ordinance was accordingly amended in 1966 to invest the CDA with municipal powers.

To carry out the above duties, the CDA has the organization as shown in Table 3.5-1.

In February, 1970, the Directorate of General Works were sanctioned at a meeting of the Board of CDA and the system is currently being reorganized as shown in Table 3.5-2.

In the new organization, water supply works are still covered by Water Research & Planning Cell, Design Directorate - Division II and Water & Sewerage Directorate, and are controlled under Director General Works, together with road, building and housing.

Personnel

Deputy Director, Water Research & Planning Cell is an engineer who has been engaged in structural designing at the Building Directorate. The Director Design also does designing of road and bridges. In the assistant engineer class, there are some who are engaged in water supply works only. But director class engineers are general civil engineers working on road, bridge and building, and there are no directors who are specialized in water supply.

Listed below are engineers of the total personnel who are associated with water supply works:

| | |
|---|---|
| Directors .................... | 3 |
| Deputy Directors ............. | 6 |
| Assistant Engineers .......... | 17 |
| Overseers .................... | 43 |
| Total | 69 |

FIG 3.5-I ORGANIZATION CHART – I

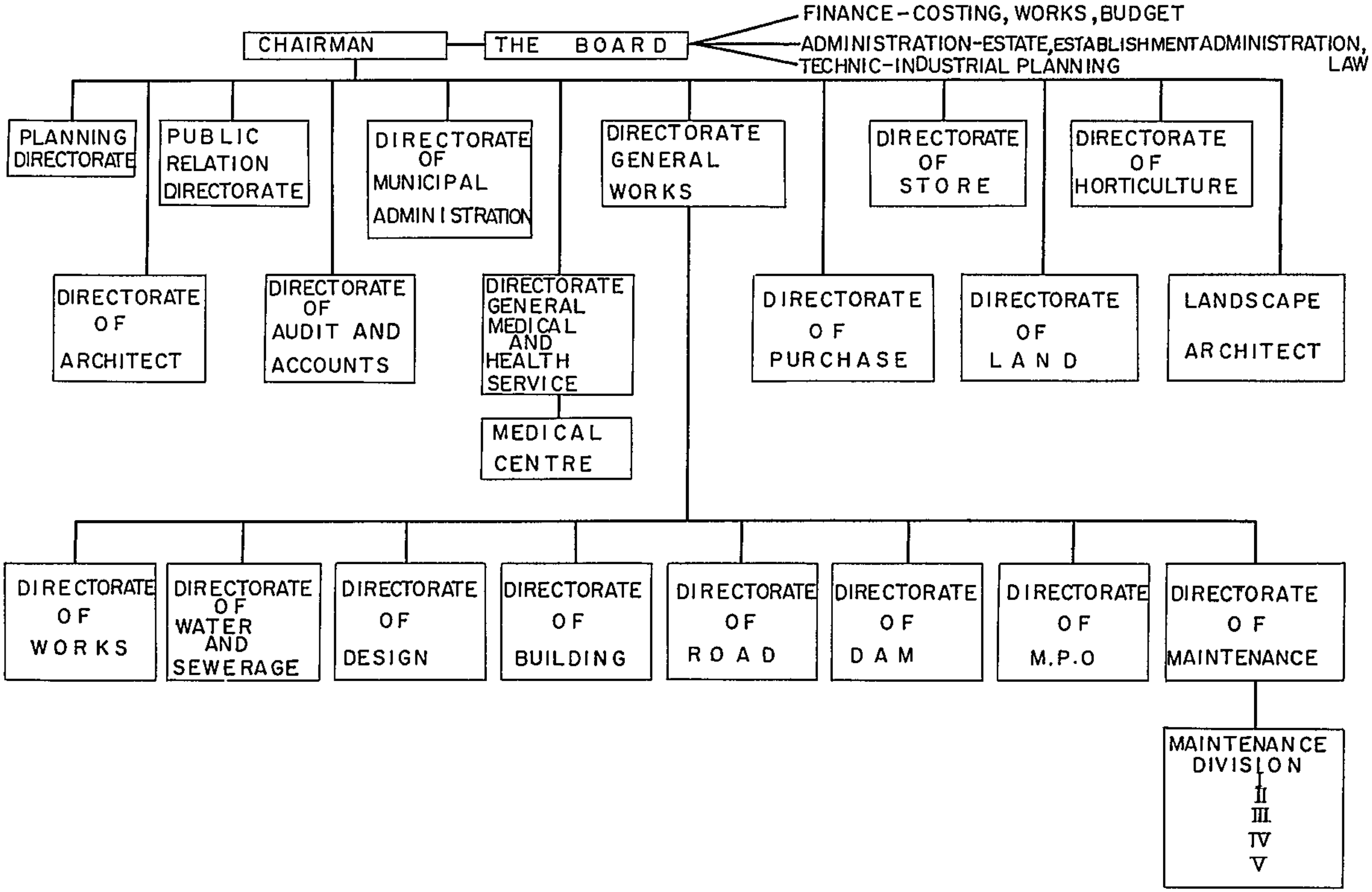


Table 3.5-2 Organization Chart - II

- Director General Works
  - Deputy Director General Works
    - Coordination/Inspection Cell
    - Deputy Director Contract/Claims
    - Deputy Director (Q.S)
    - A.A.O (works)
    - A.A.O (Establishment)
      - Cash Branch
      - R. & I. Section
    - Water Research & Planning Cell
    - Accounts Office (DGW)
    - Design Directorate
      - Design Division - I (Roads)
      - " - II (Services)
      - " - III(Structural)
    - Building Directorate
      - Building Division - I
      - " - II
      - " - III
    - Works Directorate
      - Division I, II, III, E/M
    - Road Directorate
      - Division I, II
      - Drainage & Roads Maint, Division
    - Water & Sewerage Directorate
      - Sewerage Division
      - Water Division I & II
      - Dam Construction Division
    - Maintenance Directorate
      - Division I, II & III
      - E and M Division
    - Mixing Plant and Operation Directorate
    - Staff for Engineering Laboratory
    - Comptroller
    - Accounts Staff

At present, 1,500 laborers are employed, constituting three groups each composed of 500 persons. Their classes and basic payment are as listed below.

| Classes | Monthly Payment | Annual Increment |
|---|---|---|
| Foreman | Rs. 300 | Rs. 15 |
| Fitting mechanician | Rs. 175 | Rs. 5 |
| Fitter | Rs. 125 | Rs. 5 |
| Operator | Rs. 125 | Rs. 5 |
| Clerical staff | Rs. 125 | Rs. 5 |
| Watchman | Rs. 80 | Rs. 1 |

As no increment has been provided for the past 6 - 7 years, a labor strike occurred on April 9, 1970 but was called off in half a day with mutual understanding between laborers and management. They have a labor union, which is rather moderate.

Expenditures on the maintenance and operation of water supply in Islamabad, including personnel expenses, are as follows:

| Year | Expenditures |
|---|---|
| 1968 | Rs. 1,585,710 |
| 1969 | Rs.(2,000,000) |

# CHAPTER 4

## THE PROPOSAL

4.1 Population Projection

- 4.1.1 Estimation of the Current Population
- 4.1.2 Existing Population Forecasts
- 4.1.3 Future Population

4.2 Water Demand

- 4.2.1 Average Day Consumption
- 4.2.2 Variation in the Demand of Water
- 4.2.3 Water Demand
- 4.2.4 Design Criteria

4.3 Water Supply System

4.4 Rehabilitation Works (1970)

- 4.4.1 Simly Transmission Main
- 4.4.2 Distribution Main
- 4.4.3 Water Meter

4.5 1st Stage Works (1971 - 1980)

- 4.5.1 Simly Dam
- 4.5.2 Extention of Simly Transmission
- 4.5.3 Distribution System of Simly Filteration Plant

4.6 2nd Stage Works (1980 - 2000)

- 4.6.1 Water Source
- 4.6.2 Proposed Khampur Treatment Plant
- 4.6.3 Distribution System of Propost Khampur Treatment Plant

## CHAPTER 4

## THE PROPOSAL

### 4.1 Population Projection

One of the fundamental elements in the planning of water works is population. To forecast future population, it is necessary to exactly know the current population and then proceed to estimate the future population on the basis of the past trend of population increase and simultaneously taking into account other factors which influence the population increase.

In this section, the current population is first studied, and next some forecasts on future population by various experts are reviewed. The conclusion of the Team is given in the last paragraph.

#### 4.1.1 Estimation of the Current Population of Islamabad

There are few data of current population in the Capital City of Islamabad.

A Preliminary Study on Population Projection of Islamabad, prepared by Technical Committee, Physical Planning and Housing Section of the Planning Commission, on 22nd October, 1969, estimates the current population which is as follows:

Only the number of Public Servants Houses constructed by the CDA ever since Islamabad came into existance is given yearly. In addition to Public Servants Houses there has been private house construction in Islamabad. By June, 1969 about 800 numbers of private houses are reported to have been completed against 7,800 numbers of Public Servant Houses. The ratio of Public Servant Houses to private houses works out to be 10:1. Considering the multi residential dwelling unit in Sector F-7 and F-8 and the domestic servants in the servant quarters of private house, it can be safely assumed that there are two families in each private houses. Therefore the ratio of population living in public service houses versus private houses would be 5:1. Applying above the population in Islamabad is given as the figures in the following Table 4.1-1, Estimated Current Population by Planning Committee.

In April, 1970, The Japan Survey Team studied the size of family and servants about 60 numbers of houses, selecting at random, out of about 8,000 numbers of houses.

Details are shown in Table 4.2-5.

Among the houses studied by The Team, 22 are for public servant houses, 21 are private houses and 7 are used as government offices.

The average of residential population of one public servant house including its servants, is estimated as 6.4 persons. The average of one private house is estimated as 5.9 persons. By this data, Table 4.1-1 is amended as Table 4.1-2.

The CDA Planning Directorate has suggested that the following floating population including commuters in 1969 is to be added on the above figures:

Labor force working and living at various construction sites ........... 15,000 Approx.

Commuters ................................ 5,000 Approx.

Table 4.1-1

Estimated Current Population by Technical Committee, Planning Commission

| Year | Number of public servant houses | Rough estimate of population living in these quarters by assuming an average family size of 5 persons | Number of private houses by assuming the ratio of public servant to private houses is 10:1 | Rough estimate of population living in private houses by assuming an average family size of 10 persons | Total population |
|---|---|---|---|---|---|
| 1962 | 600 | 3,000 | 70 | 600 | 3,600 |
| 1963 | 2,250 | 11,250 | 225 | 2,250 | 14,500 |
| 1964 | 3,200 | 16,000 | 320 | 3,200 | 19,200 |
| 1965 | 5,100 | 25,500 | 510 | 5,100 | 30,600 |
| 1966 | 5,650 | 28,250 | 565 | 5,650 | 33,900 |
| 1967 | 6,250 | 31,250 | 625 | 6,250 | 37,500 |
| 1968 | 6,300 | 31,500 | 630 | 6,300 | 37,800 |
| 1969 | 7,800 | 39,000 | 780 | 7,800 | 46,800 |

Table 4.1-2

Estimated Current Population
by
The Japan Survey Team

| Year | Number of public servant houses | Rough estimate of population by assuming an average family size of 6.6 person | Number of private houses by assuming the ratio of public servant to private houses is 10:1 | Rough estimate of population living in private houses by assuming an average family size of 5.9 persons | Total population |
|---|---|---|---|---|---|
| 1962 | 600 | 3,960 | 60 | 354 | 4,314 |
| 1963 | 2,250 | 14,850 | 225 | 1,328 | 16,178 |
| 1964 | 3,200 | 21,120 | 320 | 1,888 | 23,008 |
| 1965 | 5,100 | 33,660 | 510 | 3,009 | 36,669 |
| 1966 | 5,650 | 37,290 | 565 | 3,334 | 40,624 |
| 1967 | 6,250 | 41,250 | 625 | 3,688 | 44,988 |
| 1968 | 6,300 | 41,580 | 630 | 3,717 | 45,297 |
| 1969 | 7,800 | 51,480 | 780 | 4,602 | 56,082 |

Table 4.1-3

Estimated Current Population in Islamabad

| Year | Total population (1) | Annual increase of population (2) | Annual percentage growth rate (3) | Note |
|---|---|---|---|---|
| 1962 | 19,314 | | | First move to Islamabad |
| | | 11,864 | 61.4 | |
| 1963 | 31,178 | | | |
| | | 6,830 | 21.9 | |
| 1964 | 38,008 | | | |
| | | 13,661 | 35.9 | |
| 1965 | 51,669 | | | |
| | | 3,955 | 7.7 | |
| 1966 | 55,624 | | | |
| | | 4,364 | 7.8 | |
| 1967 | 59,988 | | | |
| | | 309 | 0.5 | |
| 1968 | 60,297 | | | |
| | | 10,785 | 17.9 | |
| 1969 | 71,082 | | | |

As the number of commuters has been excluded in water supply population in the past estimation, approx. 15,000 persons of labor must be added as water supply population. Thus, Table 4.1-2 is amended as Table 4.1-3.

### 4.1.2 Existing Population Forecasts

(a) M/S Doxiadis Associate Estimate made in 1960

The first forecast was made by Doxiadis Associates of Athens which is given in Table 4.1-5 and Fig. 4.1-1. While making the population projections they assumed that the number of employees needed by the civil service five years after start of construction will be 9,000 persons while the anticipated increase in population would be 7,200 families or 36,000 persons. An unspecified number of construction workers were added to this figure. It was estimated by the Doxiadis Associates that the population in 1965 is 50,000 and in 1980 400,000. Out of 400,000 in 1980, 270,000 is public employees and the rest in other professions.

(b) Price estimates made in 1968

The second population forecast was made in 1968 by Mr. Clive

J. Price, a Colombo Plan adviser in his study of water supply to Islamabad. The forecast estimates a population of some 50,000 in 1968 and retains the target of some 400,000 by 1980. The annual growth rates between 1968 to 1980 period are extremely high. Mr. Price states that beyond 1980 it is assumed that growth is not pressured but that private enterprise, Government Associated groups and industry will be responsible for the growth which is assumed at a rate comparable with the current growth rate in Rawalpindi. Estimate is given in Table 4.1-5 and Fig. 4.1-1.

(c) Planning Commission estimates made in 1969

Normally population change in any area occurs by deaths, births and migration. In case of Islamabad deaths and births would play a very small role in the overall rate of increase of population because majority of the population belongs to National and International civil servants who are not likely to live in Islamabad permanently and hence would be continuously replaced by new ones. However, migration will play a very important role for many years to come.

The potential for migration is very large for Islamabad because huge number of offices have yet to be shifted from Karachi and Rawalpindi to Islamabad. But the limiting factor is the availability of facilities which is the major factor in the development of Islamabad. Because of the limitation of facilities, the shifting of offices to Islamabad will have to be phased out. Assuming that the political, economic, social organizations and institutions of Pakistan will remain substantially unchanged and there will be no war, internal revolution and nation wide devastation then it may be hoped that during the next 10 years the tempo of construction works will further increase slightly than has been during the past. Accordingly there will be proportional increase in service population, people employed in construction and other profession. On the basis of above-mentioned assumption as well taking into account the tentative Fourth Plan allocation for Islamabad and projecting the prevailing high rate of private house construction, Planning Committee has come up with three alternative figures given below:

| Year | Alternative A growth under best condition | | Alternative B growth under normal condition | | Alternative C growth under adverse condition | |
|---|---|---|---|---|---|---|
| | Population | Increase (%) | Population | Increase (%) | Population | Increase (%) |
| 1970 | 75,000 | 11.8 | 75,000 | 11.8 | 75,000 | 11.8 |
| 1975 | 120,000 | 60.0 | 115,000 | 55.5 | 113,000 | 50.7 |
| 1980 | 175,000 | 45.8 | 153,000 | 33.0 | 136,000 | 20.3 |
| 1985 | 220,000 | 25.7 | 190,000 | 23.5 | 162,000 | 19.1 |

It is safer to adopt a higher set of figures for population forecast especially from Water Supply requirements. Estimate is given in Table 4.1-5 and Fig. 4.1-1.

(d) Planning Directorate, CDA estimates made in 1969

The city of Islamabad has been planned in a linear fashion with a pre-determined growth in eastern direction. The grid plan pattern of chess-board further establishes the size and dimension of each sector, thereby giving a fairly accurate assessment of scope of development in terms of zoning and density.

Programme of development for the 4th plan period i.e. 1970-75 has been prepared by the CDA, pattern of development of sectors will be such as mentioned below:

i) G series will contain high density residential development for low income group of staff of Attached Department;

ii) F series will be planned for private development;

iii) E series will have residential development of middle/high income group Government/Attached Departments;

iv) H series are reserved for institution;

v) I series are reserved for industries, workers and displaced persons.

From this it is expected that by 1985 the extent of growth of Islamabad will be as Table 4.1-4.

Table 4.1-4

Population Projection as Planned by 1985

| | | |
|---|---|---|
| G-6 | 25,000 | |
| F-6 | 12,000 | |
| G-7 | 32,000 | |
| F-7 | 15,000 | |
| E-7 | 2,000 | |
| G-8 | 45,000 | |
| F-8 | 15,000 | |
| H-8/I-8 | 5,000 | |
| G-9 | 45,000 | |
| F-9 | Garden | |
| E-9 | 10,000 | |
| H-9 | 5,000 | |
| I-9 | 13,000 | |
| G-10 | 45,000 | |
| H-10 | 5,000 | |
| I-10 | 15,000 | |
| I-11 | 5,000 | |
| I-14 | 12,000 | |
| I-15 | 12,000 | |
| I-16 | 12,000 | |
| F-10 | 15,000 | |
| F-11 | 10,000 | |
| E-10 | 10,000 | |
| E-11 | 15,000 | |
| D-10/D-11 | 8,000 | |
| G-11 | 45,000 | |
| H-11 | 5,000 | |
| Public bldg area | 10,000 | |
| Blue area | 4,000 | |
| Diplomatic enclave | 9,000 | |
| Administrative sector | 5,000 | |
| National park area | 12,000 | |
| Labour force | 20,000 | |
| Total | 503,000 | Say = 500,000 |

The calculation of expected population beyond 1985 is not practical and even, if calculated, the resultant figure will not be dependable at all. However, it can be assumed that by the year 2,000 the population of Islamabad will be in the vicinity of 1,000,000 but may not cross this limit.

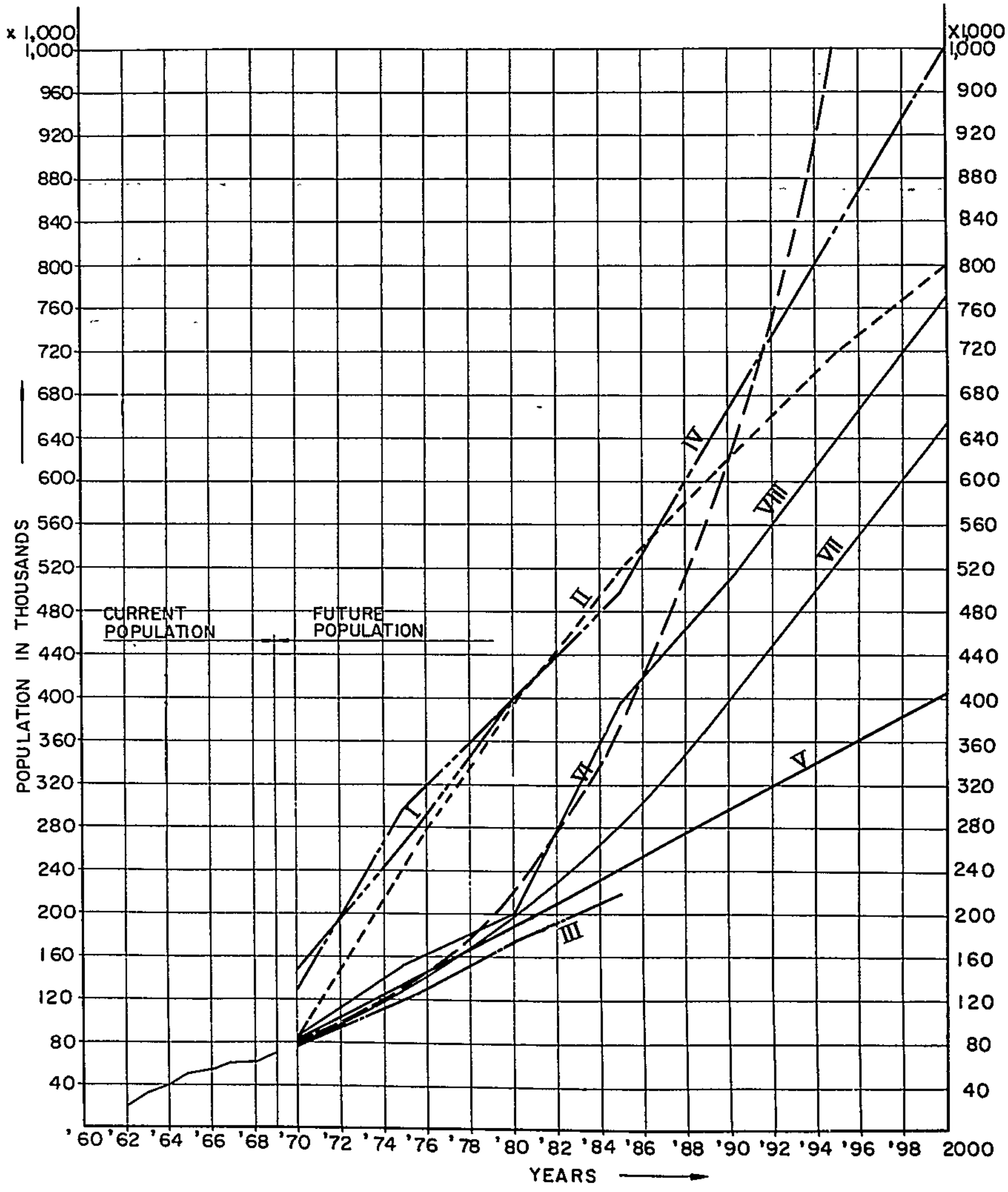
Table 4.1-5

Existing Population Forecast for Islamabad

| Year | (a) M/S Doxiadis Associate estimate made in 1960 | (b) Mr. Price estimate made in 1968 | (c) Planning Commission estimate made in 1969 | (d) Planning Directorate, CDA estimate made in 1969 |
|---|---|---|---|---|
| 1965 | 50,000 | - | - | |
| 1970 | 150,000 | 85,000 | 75,000 | |
| 1975 | 270,000 | 250,000 | 120,000 | |
| 1980 | 400,000 | 395,000 | 175,000 | |
| 1985 | | 520,000 | 220,000 | 500,000 |
| 1990 | | 620,000 | | |
| 1995 | | 720,000 | | |
| 2000 | | 800,000 | | 1,000,000 |

FIG. 4.1-1

PROJECTED POPULATION IN ISLAMABAD



4.1.3 Future Population

Future projection of population is a difficult task. While several methods are used caution must be exercised as to which method is most applicable to a community under consideration. In case of Islamabad there will never be an accurate forecast of population over the next thirty years since economic growth, accelerated Government transfers, attraction to the capital of enterprises tend to increase the population in an extra-ordinary manners during the early years of the city's growth. A knowledge of the city and its environs, and the future state of development should all enter into the consideration of future population.

The figures arrived at by the present study are, therefore, only tentative and will have to be further refined by undertaking a more detailed study and a continuous observation over the growth of population so as to enable precise and accurate forecast for the future.

(a) Arithmetical method

This method consists of adding to the existing population the same number for each future period. When plotted, it is of course a straight line. This method is of limited value but is most applicable to old and very large cities and also to small cities with no manufacturers, which depend upon a well-developed farming territory. Future population of Islamabad estimated by this method is as follows.

| Year | Total Population | Increase | Percentage of Annual Increase |
|---|---|---|---|
| 1962 | 19,314 | | |
| 1963 | 31,178 | 11,864 | 61.4 |
| 1964 | 38,008 | 6,830 | 21.9 |
| 1965 | 51,669 | 13,661 | 35.9 |
| 1966 | 55,624 | 3,955 | 7.7 |
| 1967 | 59,988 | 4,364 | 7.8 |
| 1968 | 60,297 | 309 | 0.5 |
| 1969 | 71,082 | 10,785 | 17.9 |

Average annual increase from 1962 to 1965 is approx. 10,7855 and this figure is just same to the increase from 1968 to 1969.

The future population estimated by arithmetical method is shown in Table 4.1-9, where an annual increase rate of 10,785 persons was adopted.

(b) Percentage rate of growth

Some cities grow at rate corresponding to a percentage of the population of the preceding period. This rate of growth when plotted, produces a compound interest curve. Because of this, must be used with caution when applied to a city which is young, with rapidly expanding industries, since a condition that may exist will only for a comparatively short time, and applying a percentage obtained at this period will lead to an overestimate. On the other hand, the uniform percentage applied to old cities not undergoing great expansion, may produce underestimated figures.

The percentage rate of annual growth of population in Islamabad is shown in the following Table 4.1-6.

Table 4.1-6

Percentage Rate of Annual Growth of Population in Islamabad

| Year | Percentage rate of annual growth | Note |
|---|---|---|
| 1962-1969 | 20.5 | |
| 1963-1969 | 14.7 | |
| 1964-1969 | 13.3 | |
| 1965-1969 | 8.3 | The war with India in September of 1965 |
| 1966-1969 | 8.5 | |
| 1967-1969 | 10.9 | |
| 1968-1969 | 17.9 | |

If the future population in Islamabad is estimated by the percentage of annual growth in these three years between 1967-1969 when the war with India which broke out in September, 1965 has been ended, the population in 2,000 will be 1,756,000.

But this figure is unreasonably high. It seems more practical that the percentage rate in Islamabad in 2,000 will be almost similar to that of Lahore City, the Capital of West Pakistan. By the 1960's census report, the average national annual percentage growth rate in Pakistan is 2.50. And the annual percentage growth rate for other cities of Pakistan are estimated as follows:

Table 4.1-7

Annual Percentage Growth Rate for Several Cities in West Pakistan

| (City Name) | Hyderabad | Multan | Gujranwala | Lahore |
|---|---|---|---|---|
| (Year) | up to 1985 | 1975/1990 | 1971/1981 | up to 1981 |
| (Estimated annual percentage) | 6.00 | 4.73 | 4.97 | 4.1 |
| (Method) | by constant annual percentage | Geometrical comparison | Geometrical comparison | Constant annual percentage |
| (Estimated by) | M/S Parson | M/S Parson | M/S Parson | M/S Nihon Suido |

Table 4.1-8

Population Projection with Decreasing Growth Rate

| Year | Percentage Rate of Growth | Population | |
|---|---|---|---|
| 1970 | 10.9 | 78,830 | ( 79,000) |
| 1975 | 9.75 | 128,170 | (128,000) |
| 1980 | 8.6 | 197,745 | (198,000) |
| 1985 | 7.45 | 289,336 | (289,000) |
| 1990 | 6.31 | 401,344 | (401,000) |
| 1995 | 5.16 | 527,519 | (528,000) |
| 2000 | 4.1 | 656,993 | (657,000) |

(c) Future population

Future population is estimated by various persons and also estimated on different methods as stated before, and the summarization in general is as follows:

Table 4.1-9

Projected Population in Islamabad

| Year | M/S Doxiadis Associate estimate made in 1960 | Mr. Price estimate made in 1968 | Planning Commission estimate made in 1969 | Planning Directo-rate CDA estimate made in 1969 | Arithme-tical method | Constant percent-age rate of growth | Decreas-ing per-centage rate of growth |
|---|---|---|---|---|---|---|---|
| | (I) | (II) | (III) | (IV) | (V) | (VI) | (VII) |
| 1970 | 150,000 | 85,000 | 75,000 | 130,000 | 81,867 | 78,829 | 78,830 |
| 1975 | 270,000 | 250,000 | 120,000 | 300,000 | 135,792 | 132,231 | 128,170 |
| 1980 | 400,000 | 395,000 | 175,000 | 400,000 | 189,717 | 221,813 | 197,745 |
| 1985 | | 520,000 | 220,000 | 500,000 | 243,642 | 372,083 | 289,336 |
| 1990 | | 620,000 | | | 297,567 | 624,160 | 401,344 |
| 1995 | | 720,000 | | | 351,492 | 1,047,014 | 527,519 |
| 2000 | | 800,000 | | 1,000,000 | 405,417 | 1,756,344 | 656,993 |
| | | | | | Annual increment is 10,785 persons | Annual percent-age is 10.9% | 1970=10.9%<br>1980= 8.6%<br>1980= 6.31%<br>2000= 4.1% |

Taking into consideration all the informations stated above, it is recommended that decreasing annual growth rate from 10.9% in 1970 to 4.1% in 2,000 might be adopted for the population projection upto 2,000, as indicated under column (VII) in Table 4.1-9.

Water demand in this report is estimated on the basis of the above projected population, which is in details described in the following section (d).

(d) Future population decided by Planning Commission Government of Pakistan in July, 1970.

In case of Islamabad migration will play a very important role because the shifting of offices to Islamabad will have to be phased out by the Government. Taking into account the tentative Forth Plan allocation for Islamabad and projecting the prevailing high rate of private house construction, Planning Committee, Government of Pakistan has decided the future population in Islamabad upto 1985 in July, 1970.

The difference of population in 1985 between the figures by Planning Committee and by The Japan Survey Team is 110,664 persons only.

The population of 110,664 persons is fairly due to migration from Karach and Rawalpindi to Islamabad. The future population recommended on the bases of decreased annual growth rate as indicated under column (VII) in Table 4.1-9 should be amended by the schedule of Government and the population of 110,664 persons was added after 1985 to column (VII) in Table 4.1-9 as shown in the following table:

Table 4.1-10

Projected Population in Islamabad by Planning Committee, Government of Pakistan

| | |
|---|---|
| 1970 | 75,000 |
| 1975 | 150,000 |
| 1980 | 225,000 |
| 1985 | 400,000 |
| 1990 | 512,000 |
| 1995 | 638,000 |
| 2000 | 768,000 |

Water demand in this report is estimated by the above projected population shown in Fig. 4.1-1 as VIII.

## 4.2 Water Demand

### 4.2.1 Average Day Consumption

- Actual Water Consumption

The following Table 4.2-1 shows the actual water consumption per capita per day calculated by the current population and the record of water production in different water sources while the figures seem to be rather on the high side.

Table 4.2-1

Actual Water Production per Capita

| Year | Current Population | Total Water Production mgd | Average Day Consumption per Capita per Day gpcd |
|---|---|---|---|
| 1965 | 51,669 | 3.14 | 60.8 |
| 1966 | 55,624 | 6.49 | 116.7 |
| 1967 | 59,988 | 7.48 | 124.7 |
| 1968 | 60,297 | 7.70 | 127.7 |
| 1969 | 71,082 | 9.09 | 127.9 |

a. Example of other cities of Pakistan

Estimated demand of the other cities comes to 34 to 50 gpcd, as illustrated below:

Table 4.2-2

| Name of Community | Actual | Year Estimated | | | |
|---|---|---|---|---|---|
| | 1968 | 71 | 75 | 80 | 90 |
| Lahore | 34 | - | 36 | 45 | - |
| Multan | - | 40 | 40 | 40 | 50 |
| Hyderabad | - | 35 | - | 45 | 50 |
| Gujranwala | - | - | 40 | - | 50 |

closets, bath and water needs of bazaars and schools after giving allowance for leakages and wastage.

4) The average consumption of rural water supply is taken at 22 to 30 gpcd including needs for the items as mentioned in (3) above.

Table 4.2-3 Examples of Water Consumption in Japan (gpcd)

| Name of Community | Population Served (1967) | Average Consumption (Maximum day consumption) gpcd '57 | '58 | '59 | '60 | '61 | '62 | '63 | '64 | '65 | '66 | '67 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1504 Communities | x $10^3$ 63.126 | - | - | - | 60 | 62 | 62 | 63 | 65 | 76 | 67 | 71 |
| | | - | - | - | (75) | (78) | (79) | (80) | (81) | (85) | (88) | (91) |
| TOKYO | 8.246 | 66Av. | 67 | 72 | 74 | 77 | 74 | 74 | 80 | 88 | 91 | 89 |
| | | (75)Max. | (76) | (81) | (82) | (89) | (87) | (89) | (89) | (105) | (106) | (111) |
| OSAKA | 3.063 | 81Av. | 85 | 86 | 88 | 92 | 96 | 102 | 111 | 115 | 122 | 128 |
| | | (96)Max. | (102) | (104) | (107) | (111) | (118) | (124) | (134) | (145) | (152) | (158) |
| NAGOYA | 1.899 | - | - | 72 | 75 | 78 | 80 | 80 | 82 | 80 | 80 | 83 |
| | | - | - | (91) | (96) | (97) | (103) | (101) | (109) | (110) | (110) | (104) |
| YOKOHAMA | 1.825 | 90Av. | 89 | 91 | 89 | 96 | 96 | 89 | 85 | 82 | 86 | 90 |
| | | (107)Max. | (106) | (104) | (102) | (119) | (120) | (112) | (101) | (103) | (108) | (108) |
| KANAGAWAKEN | 1.029 | 66Av. | 60 | 60 | 59 | 63 | 64 | 63 | 61 | 60 | 61 | 61 |
| | | (87)Max. | (79) | (78) | (76) | (82) | (85) | (85) | (82) | (84) | (83) | (81) |
| HIROSHIMA | 527 | 74Av. | 76 | 86 | 80 | 79 | 80 | 80 | 80 | 82 | 83 | 84 |
| | | (92)Max. | (91) | (101) | (94) | (98) | (99) | (100) | (100) | (102) | (104) | (105) |
| SAPPORO | 493 | 50Av. | 44 | 43 | 46 | 48 | 51 | 55 | 55 | 54 | 56 | 56 |
| | | (56)Max. | (58) | (56) | (58) | (61) | (61) | (68) | (67) | (67) | (69) | (68) |

c. Example of other cities in the world

The cases of the other cities in the world is given in the

Table 4.2-4

| Name of Community | Population Served | Average Day Consumption , gpcd | Max. Day Consumption gpcd | Max. Houre Consumption gpcd | Note |
|---|---|---|---|---|---|
| NICOSIA | x$10^3$ 105 | 52 | - | - | |
| MONROVIA | 92 | 28 | - | - | 1967 |
| CAPETOWN | 950 | 29 | 46 | 58 | 1965 |
| ATHENS | 1,853 | 32 | - | - | 1965 |
| PARIS | 2,760 | 64 | 74 | - | 1969 |
| ROME | 2,682 | 99 | 118 | - | 1968 |
| LONDON | 6,132 | 62 | 80 | - | 1968 |
| CHICAGO | 4,703 | 183 | 298 | - | 1968 |
| KABUL | 237 | 13 | 36 | - | 1968 |
| COLOMBO | 550 | - | 55 | - | 1968 |
| KUALA LUMPUR | 1,100 | 38 | 48 | - | 1968 |

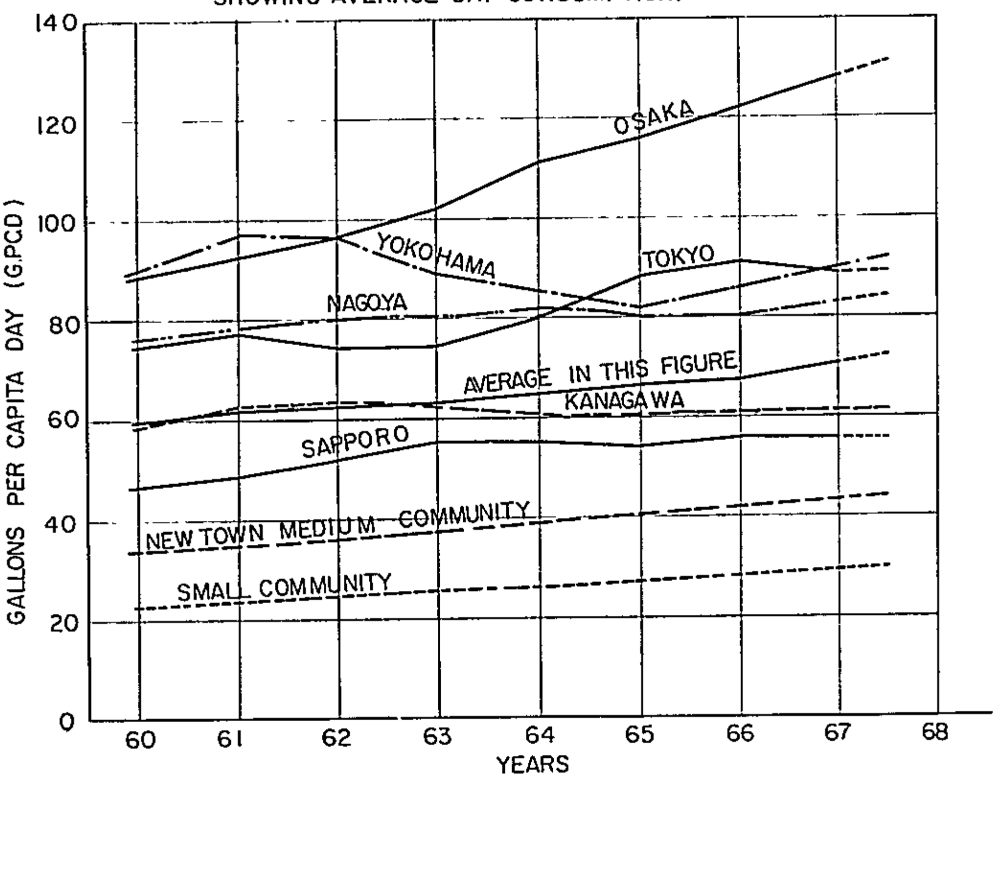
b. Example of cities in Japan

1) In 1960 the average consumption of 1504 cities including big cities was in the order of 60 pgcd and in 1967 it has risen to 70 gpcd due to the tremendous expansions and developments of industries in the country. The average consumption in Tokyo in 1960 was in the order of 74 gpcd, in Osaka 88 gpcd, in Nagoya 75 gpcd, in Yokohama 89 gpcd, in Kanagawa 59 gpcd, in Hiroshima 80 gpcd, and in Sapporo 46 gpcd. In all these cities commercial, industrial and community activities concentrate as a local centre, having all social and cultural activities in full swing.

2) The above mentioned average consumption of water includes 30% leakages and wastage.

3) According to the design criteria for a new town planning, the estimated average consumption of water is taken at 45 gpcd for domestic use, gardening, washing machines, water

FIG 4.2-2 PROGRESSIVE WATER CONSUMPTION IN VARIOUS COMMUNITIES OF WATER SUPPLY IN JAPAN SHOWING AVERAGE DAY CONSUMPTION.



- Field Survey

Water consumption per capita varies in a wide range, depending on the standard of living, social environments, available quantity of water, climatic conditions, metering, water rate, operation of the system, etc.

The domestic use (drinking, cooking, baths, washing, water closets, cleaning and gardening) is the larger part of total water consumption. This figure varies from country to country and city to city. Since the water supply has been limited and restricted in Islamabad due to shortage of water, it is not possible to ascertain the actual consumption per capita.

The Team surveyed certain category of houses to find out actual consumption of water, especially the water used for domestic purpose.

Reading of some 60 numbers of water meters, selected at random, was done during March 30 - April 13, 1970. Table 4.2-5 shows the weather condition during the survey period and Table 4.2-6 shows the survey result.

Table 4.2-5

The Weather Condition During The Survey Period

| Date Month | Day | Temperature Max. °C | °F | Min. °C | °F | Weather |
|---|---|---|---|---|---|---|
| March | 30 Mon. | 29.0 | 84.0 | 9.3 | 48.5 | Fair |
| | 31 Tue. | 28.8 | 84.0 | 10.8 | 51.5 | " Humidity = 23% |
| April | 1 Wed. | 30.0 | 85.8 | 10.0 | 50.0 | " " = 17% |
| | 2 Thur. | 30.2 | 86.5 | 9.2 | 48.5 | " " = 80% |
| | 3 Fri. | 30.5 | 87.0 | 10.8 | 51.5 | " " = 16% |
| | 4 Sat. | 31.8 | 89.5 | 11.3 | 53.5 | " " = 17% |
| | 5 Sun. | 32.5 | 91.0 | 12.0 | 64.0 | Fair to cloudy, humidity 18% |
| | 6 Mon. | 33.0 | 92.0 | 14.5 | 58.8 | Fair cloudy, dust thunderstorm in the evening, humidity 16% |
| | 7 Tue. | 32.0 | 90.0 | 20.0 | 68.0 | Cloudy occasional thunderstorm rain, humidity 25% |
| | 8 Wed. | 32.3 | 90.1 | 14.7 | 58.5 | Fair to cloudy thunderstorm dust, raising wind evening/night, humidity 38% |
| | 9 Thur. | - | - | - | - | Fair to cloudy, humidity 24% |
| | 10 Fri. | 35.0 | 95.0 | 14.5 | 58.0 | Fair/cloudy, dust thunderstorm followed by rain evening/night humidity 17% |
| | 11 Sat. | 37.0 | 99.0 | 14.5 | 58.0 | Cloudy, occasional dust/thunderstorm followed by rain evening/night, humidity 17% |
| | 12 Sun. | 37.0 | 99.0 | 18.0 | 64.0 | Cloudy, occasional dust/thunderstorm followed by rain evening/night, humidity 23% |
| | 13 Mon. | 32.1 | 89.8 | 20.5 | 69.0 | |

Table 4.2-6

| | Reading 30/3/70 to 13/4/70 gpd | Numbers of family members | Remarks | gpcd | Average of garden sq. ft. | Amounts of water consumption from water meter reading gal/month | Amounts of water consumption per month from record at CDA gal/month |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1 | Water leaking | 7 | | - | 1,925 | - | 6,000 |
| 2 | No glass | 7 | | - | 1,400 | - | 4,500 |
| 3 | No glass, no hand | 7 | | - | 1,400 | - | 4,000 |
| 4 | - do - | 5 | | - | 1,400 | - | 4,000 |
| 5 | - do - | 11 | | - | 1,400 | - | 5,000 |
| 6 | No glass | 20 | Office | - | 1,400 | - | 8,000 |
| 7 | Out of order | 4 | | - | 2,000 | - | 4,000 |
| 8 | No glass | 6 | | - | 1,400 | - | 4,500 |
| 9 | Out of order | 7 | | - | 1,400 | - | 4,000 |
| 10 | - do - | 8 | | - | 1,400 | - | 5,000 |
| 11 | - do - | 7 | Office | - | 1,050 | - | 10,000 |
| 12 | 825.1 | 2 | German | 412.6 | 1,050 | 24,753 | 10,000 |
| 13 | Water leaking | 7 | | - | 700 | - | 10,000 |
| 14 | 157.3 | 20 | Office | 7.9 | 495 | 4,719 | 7,000 |
| 15 | No meter | | | - | - | - | - |
| 16 | 453.0 | 45 | Office | 10.0 | 2,100 | 13,590 | 11,000 |
| 17 | Out of order | 7 | | - | 1,050 | - | 4,000 |
| 18 | 290.7 | 10 | Office | 29.1 | 1,200 | 8,721 | 15,000 |
| 19 | 184.2 | 5 | American | 36.8 | 1,400 | 5,526 | 26,000 |
| 20 | Out of order | 16 | Office | - | 1,400 | - | 15,000 |
| 21 | Water leaking | 8 | | - | 1,300 | - | 8,000 |
| 22 | 449.0 | 6 | | 74.8 | 575 | 13,470 | 8,000 |
| 23 | No glass | 8 | | - | 1,200 | - | 12,000 |
| 24 | Water leaking | 4 | | - | 150 | - | 8,000 |
| 25 | 388.5 | 5 | | 77.7 | 150 | 11,655 | 8,000 |
| 26 | 198.7 | 7 | | 28.4 | 725 | 5,961 | 15,000 |
| 27 | 352.4 | 4 | | 88.1 | 500 | 10,572 | 9,000 |
| 28 | 164.2 | 7 | | 23.5 | 400 | 4,926 | 7,000 |
| 29 | 383.6 | 9 | | 42.6 | 300 | 11,508 | 26,000 |

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| 30 | 507.2 | 6 | | 84.5 | 450 | 15,216 | 12,000 |
| 31 | 171.8 | 7 | | 24.5 | Nil | 5,154 | 8,500 |
| 32 | Water leaking | 16 | | - | Nil | - | 7,000 |
| 33 | 62.3 | 5 | | 12.4 | Nil | 1,869 | 5,000 |
| 34 | 225.6 | 3 | | 75.2 | Nil | 6,768 | 6,000 |
| 35 | Water leaking | 8 | | - | 250 | - | 6,000 |
| 36 | 181.3 | 4 | | 45.3 | 225 | 5,439 | 5,000 |
| 37 | Water leaking | 3 | Indian | - | 300 | - | 6,000 |
| 38 | 4.1 | 8 | | - | Nil | 123 | 5,000 |
| 39 | 200.7 | 8 | | 25.1 | Nil | 6,021 | 5,600 |
| 40 | Water leaking | 4 | | - | 225 | - | 8,000 |
| 41 | 100.5 | 2 | | 50.3 | Nil | 3,015 | 7,800 |
| 42 | Locked | 4 | | - | 200 | - | 6,500 |
| 43 | 200.7 | 1 | | 200.7 | Nil | 6,021 | 5,000 |
| 44 | No glass, no hand | 6 | | - | 200 | - | 5,000 |
| 45 | 6.1 | 4 | | - | Nil | 183 | 5,000 |
| 46 | 67.5 | 6 | | 11.3 | 300 | 2,025 | 8,000 |
| 47 | No working | 2 | | - | 300 | - | 8,000 |
| 48 | No glass | 8 | | - | Nil | - | 5,000 |
| 49 | 241.4 | 8 | | 30.2 | Nil | 7,242 | 5,000 |
| 50 | 549.2 | 3 | | 183.1 | Nil | 16,476 | 8,000 |
| 51 | 54.5 | 5 | | 10.9 | Nil | 1,635 | 5,000 |
| 52 | No glass, no hand | 12 | | - | Nil | - | 5,000 |
| 53 | 368.2 | 9 | | 40.9 | Nil | 11,046 | 9,000 |
| 54 | Water leaking | 6 | | - | Nil | - | 5,000 |
| 55 | 123.6 | 3 | | 41.2 | Nil | 3,708 | 5,000 |
| 56 | 179.4 | 10 | | 17.9 | Nil | 5,382 | 4,000 |
| 57 | Out of order | 6 | | - | Nil | - | 5,000 |
| 58 | 232.0 | 9 | | 25.8 | Nil | 6,960 | 5,000 |
| 59 | Not allowed in | | | | | | |
| 60 | - do - | 6 | | - | Nil | - | 5,000 |

27 meters out of 60, were working in good condition. 3 meters out of 27 were for the office. The details of water consumption per capita obtained by reading the water meters equipped at houses are as follows:

| Water consumption per capita per day calculated from meter reading gpcd | Number of houses |
|---|---|
| 0 to 10 | 0 |
| 10 to 20 | 4 |
| 20 to 30 | 5 |
| 30 to 40 | 2 |
| 40 to 50 | 4 |
| 50 to 60 | 1 |
| 60 to 70 | 0 |
| 70 to 80 | 3 |
| 80 to 90 | 2 |
| 90 to 100 | 0 |
| above 180 | 3 |
| Total | 24 |

3 houses out of 24 show more than 180 gal. of consumption per capita per day by the above table, and the average day consumption of private houses with garden except above 3 houses is 41.3 gpcd.

The water consumption of the personnel working in the Office is 15.7 gpcd. And as the number of the Office workers is estimated 1/3 of total population, the average day consumption per capita in the municipal centre area may be

$$\frac{15.7}{3} = 5.2 \text{ gpcd}$$

The Team surveyed the actual water consumption of private gardens at F-6/4, 296 area, on April 2. The area of the gardens was 1,800 sq. ft. and the water was supplied for about one hour every evening. The total quantity of the supplied water for the above was 166 gallons. As the number of family members is 6, the average day consumption for garden is 27.7 gallons in terms of per capita per day consumption.

- Report by Director Planning

According to the report on Population Projection and Water Needs for Islamabad prepared by Director Planning, CDA on November 1st, 1969, the average day water consumption is as given below:

Table 4.2-7

Average Day Water Consumption
in Islamabad

| Water usage | Percentage (%) of total water | Average day consumption gpcd |
|---|---|---|
| Private houses and minor centres | 50 | 25 |
| Private gardens | 30 | 15 |
| Municipal and major centres | 10 | 5 |
| Light industry and work-shops | 10 | 5 |
| Sub-total | 100 | 50 |
| Green spaces | | 10 |
| Loss and wastage | | 20 |
| Total | | 80 |

- Municipal Water Supply by Usage, in Japan

Details of the percentages by usage obtained in Japan are as under:

Table 4.2-8

Average Day Water Consumption in Japan in 1967

| Water usage | Percentage of water | Average day consumption gpcd |
|---|---|---|
| Domestic | 42 | 30 |
| Commercial | 14 | 9 |
| Industrial | 7 | 5 |
| Public and Government | 4 | 3 |
| Others | 8 | 6 |
| Sub-total | 75 | 53 |
| Leakage and wastage | 25 | 17 |
| Total | 100 | 70 |

Note: In the Table 4.2-8, average day consumption for 1504 communities including the big cities of Japan is 70 gpcd out of which 30 gpcd is for domestic use. This table has been prepared in consultation with the water supply statistics of Japan for the year of 1967 consisting of 1504 communities with population of more than 5,000, and the total population served is 63 millions. In the case of the new town planning in Japan, the average day consumption is taken at 45 gpcd. This consumption of water has been taken purely for the domestic use, no provision for industries, offices and other public places is made in these housing areas.

- Water for Construction

The Team investigated the daily consumption for construction, for which purpose 4 meters were installed and read for 2 weeks. The result is as follows:

| Condition of construction | Consumption Gallon per day |
|---|---|
| Construction just begun | 50.4 |
| Now placing concrete | 443.1 |
| Now just completing | 134.3 |
| Almost completed | 91.7 |

It requires approx. 4-6 months for one house construction. The construction development is being performed actively. It is advisable the shallow well, as exists at present, be dug in each Sector for construction purpose.

The water consumption for construction in the developing Sectors may be neglected because the required quantity is negligible.

- Water for Green Space

Water requirements at public green space, prepared by Director Horticulture, CDA on March 5, 1970, are given in ANNEX-4.

Water demand of about 5 mgd for public green space is a huge amount. It elaborates the requirements in details.

According to the report of Geohydrology of the Federal Capital Area, West Pakistan, prepared by Water and Soil Investigation Division, Water and Power Development Authority in 1966, the ground water investigation carried out in the capital area has shown the possibility of developing ground water for supplemental supply in significant quantities. Alluvial deposites containing sand and gravel aquifers are moderately thick and extensive; averaging perhaps 300 to 400 feet thick over a total area of 60 square miles. The thickness of individual strata of sand and gravel in the alluvium generally ranges from 10 to 50 feet. The sand and gravel generally comprise about 20 to 30 percent of the total thickness of alluvium. Yields of properly constructed and developed well in sections of alluvium 250 feet thick or more generally will range from 1/4 to 1 1/2 cusecs. The design and construction of an individual tubewell in different sections will pose different problems. In this connection advice from a competent geohydrologist at all phases of ground water development is desirable.

The aquifers are replenished by direct precipitation on the land surface and by seepage from stream. Hydrographs of wells show that water levels are responsive to precipitation and that ground water in storage is replenished during every rainy period of consequence.

If tubewells were to be properly spaced and distributed throughout the specified ground water zone, total development of 20 to 40 cusec (11 to 22 mgd) probably would be possible.

As the average life of tubewell is 5-10 years, it is recommendable, as stated before, the water for construction purpose shall be supplied by tubewells. The important is how the location of tubewells are selected. The water from tubewells can also be used for sprinkling for the public green space.

It is also recommendable to that in water at Korang and Gumreh River and supply for sprinkling at park area mentioned above.

- Water for Fire Fighting

As for fire fighting, the data supplied by Director of Municipal Administration on April 11th, 1970, give the following information.

1) 240 fire incidents took place during the last 5 years. Nearly 400,000 gallons was consumed to extinguish the fires. Water were obtained from the hydrants connected with the main water pipe line.

2) The past experience shows that the pressure was very low in the hydrants.

3) The Fire Fighting Bye-Laws (Chapter IX) is shown hereunder:

74. The Director may impose any charges on the Insurance Companies, in the event of any fire in an insured building, provided the charges will not exceed more than 1% of the annual rental value of the building or as fixed by the "Authority" from time to time.

75. All instructions issued by the Director with regard to the fire precautions in private buildings and government institutions shall be carried out.

76. The Director may appoint fireman on duty at commercial building like picture houses to avoid the risk of fire and nominal charges for the service will be recovered as may be fixed by the Authority from time to time.

77. No person shall interfere in or hamper the fire extinguishing operations of the Municipal Fire Brigade in any manner.

78. The officer in charge of fire fighting operation may take the following measures for the safety of public life and property:

1) He may pull down a portion or whole of the premises involved in fire operation.

2) He may shut off any mains of pipelines to allow better flow of water to the scene of fire and may take further measures considered essential for the preservation of life and property.

79. No persons shall be liable to pay any damages in respect of anything done in good faith while directing the fire fighting operations.

80. Any person committing a contravention of any of the bye-laws in this chapter shall on conviction be punishable with fine which may extend to five hundred rupees and in the case of a continuing contravention with an additional fine, which may

extend to twenty rupees for every day during which contravention continues after conviction for the first of such contravention.

Hours of fire occurrence are not identified but the fire broke out about twice a month and more often in January when residents use fire for heating, according to the data of Islamabad Fire Brigade. As the buildings are mostly made of bricks, the water through the hydrants equipped at green spaces in the city, may be enough for fire fighting.

- Consideration

Judging from the factors and examples explained above, it was decided to take the average consumption (that is, requirement) of water in 1970 at 50 gpcd.

The percentage rate of annual increase of average water demand for the past few current years are as follows:

| Year | Percentage rate of annual increase |
|---|---|
| 1968 - 1969 | 0.157 |
| 1967 - 1969 | 1.275 |
| 1966 - 1969 | 3.100 |

As the percentage rate of annual growth in the year 1967-1969 is used for estimation of future population in Islamabad, future average water consumption as well is calculated in the same manner by using percentage rate of annual increase in 1967-1969.

Future average water demand by year up to 2000 were estimated using to use percentage rate 1.275 of annual increase as shown in Table 4.2-9. Percentage of leakage and wastage in Table 4.2-9 is expected to reduce remarkably due to the best effort by CDA. Unaccounted-for water as leakage and wastage is due to meter, unauthorized water connections and leaks in mains. It is apparent that the unaccounted-for water, and also waste by customers, can be much reduced by careful maintenance of the water system and by universal metering of all water services. In a system 100 percent metered and moderately well maintained, the unaccounted-for water will be about 15 percent.

Table 4.2-9

Estimated Average Water Demand

| Year | Actual demand gpcd | Percentage of leakage and wastage | Demand gpcd |
|---|---|---|---|
| 1970 | 50.0 | 50% (50 gpcd) | 100 |
| 1975 | 53.3 | 44% (36.7 " ) | 95 |
| 1980 | 56.8 | 37% (33.2 " ) | 90 |
| 1985 | 60.5 | 33% (29.5 " ) | 90 |
| 1990 | 64.4 | 24% (20.6 " ) | 85 |
| 1995 | 68.6 | 19% (16.4 " ) | 85 |
| 2000 | 73.1 | 14% (11.9 " ) | 85 |

The Team used the estimation of future water demand in Table 4.2-9, for planning the project, but it will be necessary to study and analyze the actual population increase and water demand over the years to come, and to revise the plan accordingly.

### 4.2.2 Variation in the Demand of Water

In order to plan a satisfactory water supply system, it is imperative that we should know exact seasonal, daily and hourly variations of demand. But since the condition of water supply in Islamabad is such that it has never met the full demand of the people, it is not possible to have the exact idea of such a variation. Examples of other cities are helpful for estimation of variations in demand and given below in the tables 4.2-10, 11, and 12 for cities in Pakistan, Japan and other countries.

Table 4.2-10

Ratio of Average Day,
Maximum Day; Maximum Hour Demands in Pakistan

| Cities | Average day demand | Maximum day demand | Maximum hour demand |
|---|---|---|---|
| Multan | 100% | 150% | 225% |
| Hyderabad | 100% | 150% | 200% |
| Gujranwala | 100%. | 150% | 200% |
| Lahore | 100% | 150% | 225% |

Table 4.2-11

Ratio of Average Day,
Maximum Day and Maximum Hour Demands in Japan

| Cities | Average day demand | Maximum day demand | Maximum hour demand |
|---|---|---|---|
| Large city Industrial city | 100% | 120-140% | 160-200% |
| Medium & small city | 100% | 150% | 200-300% |
| Town, village, New town | 100% | 150% | 300-600% |

Table 4.2-12

Examples of Ratio of Average Day/Maximum
Day Demands in Other Countries

| Name of community | Population served (in thousand) | Maximum average ratio | Note |
|---|---|---|---|
| London | 6,132 | 1.28 | 1969 |
| Stockholm | 923 | 1.27 | 1968 |
| Hamburg | 1,930 | 1.30 | 1968 |
| Paris | 2,760 | 1.17 | 1967 |
| Wien | 1,600 | 1.32 | 1968 |
| Zurich | 435 | 1.54 | 1968 |
| Rome | 2,682 | 1.20 | 1968 |
| Philadelphia | 2,003 | 1.30 | 1967 |
| Baltimore | 1,500 | 1.44 | 1968 |
| Chicago | 4,703 | 1.63 | 1968 |
| Honolulu | 500 | 1.35 | 1968 |
| Capetown | 950 | 1.59 | 1969 |
| Kuala Lumpur | 1,100 | 1.25 | 1968 |

In Fig. 4.2-3, the ratio of maximum and average day demand for 1504 communities comes to 1.28 in 1967 and for the big cities the ratio is in the range of 1.10 to 1.40. Since the environments and the present position of Islamabad which is on its way for its final shape are similar to that of the new town planning in Japan except a difference that the city requires greater green space area to be maintained and that constructional activities will be increased in due course of time, on the basis of which we may add a special allowance to meet this extra demand of water to that which is required for the new town planning in Japan.

In Fig. 4.2-4 which has been adopted for the design criteria for the development of new town planning in Japan, it is evident that the maximum hour demand in smaller communities is much higher than that of the larger one. Taking into account the above facts and figures we have come to the conclusion that maximum day demand is 150% of average day demand and maximum hour demand is 300% of the same, but in future with the increase of the population, the maximum hour demand will gradually decrease from 300 to 250%.

On the basis of the above conclusion, the quantity of water required for population of 75,000 will be as under:

| | |
|---|---|
| Average day demand | 100 gpcd or 7.50 mgd. |
| Maximum day demand | 150 gpcd or 11.25 mgd. |
| Maximum hour demand | 300 gpcd or 22.50 mgd. |

Typical curve for seasonal and hourly variation are given in Figs. 4.2-5 and 4.2-6.

FIG 4.2 -3 VARIATION OF RATIO OF AVERAGE DAY TO MAXIMUM DAY CONSUMPTION IN JAPAN

(R)= $\frac{\text{MAXIMUM DAY CONSUMPTION}}{\text{AVERAGE DAY CONSUMPTION}}$

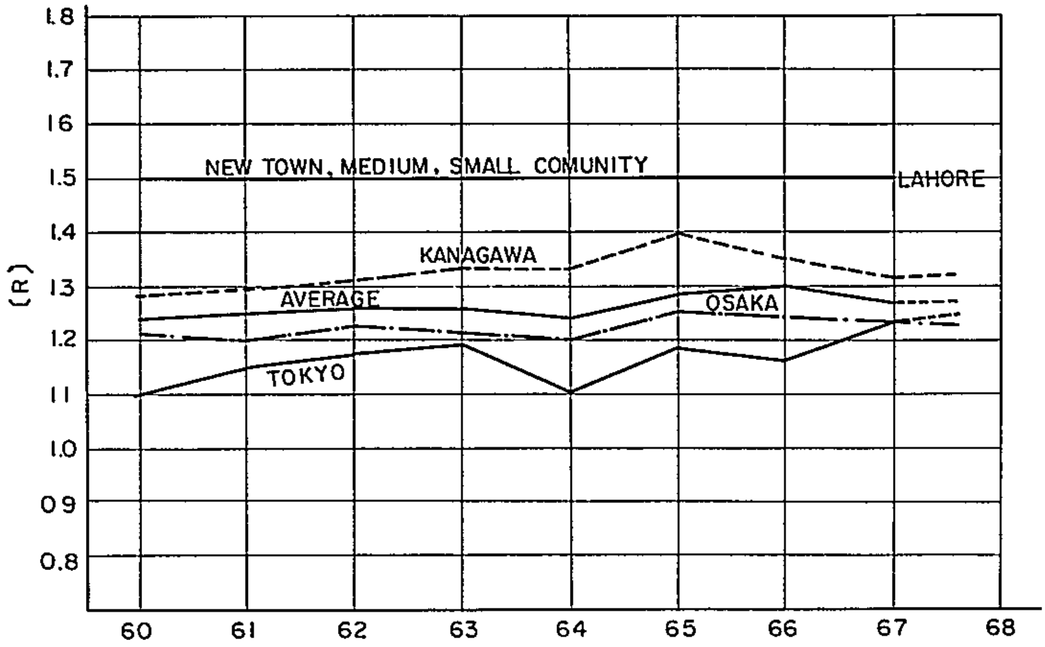



FIG 4.2-4 MAX,HOUR DEMAND/MAX, DAY DEMAND VS. POPULATION SERVED

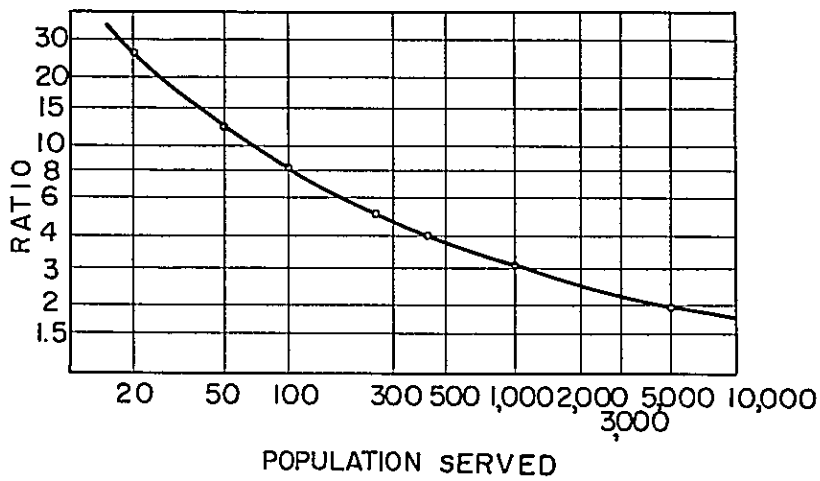


FIG 4.2-5 TYPICAL PATTERN OF SEASONAL VARIATION FOR WATER SUPPLY IN ISLAMABAD

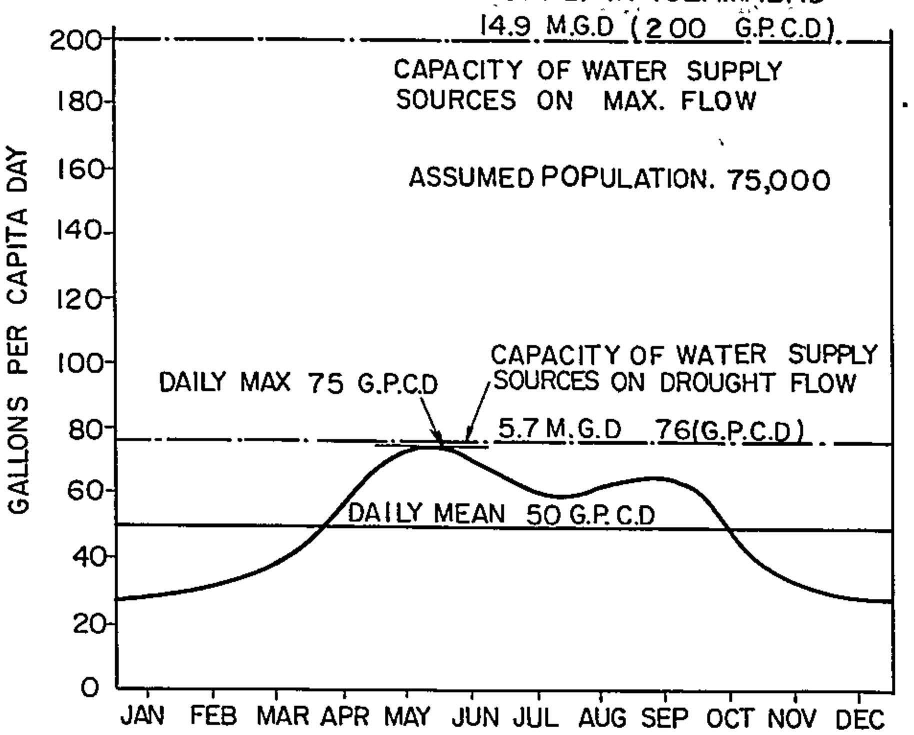
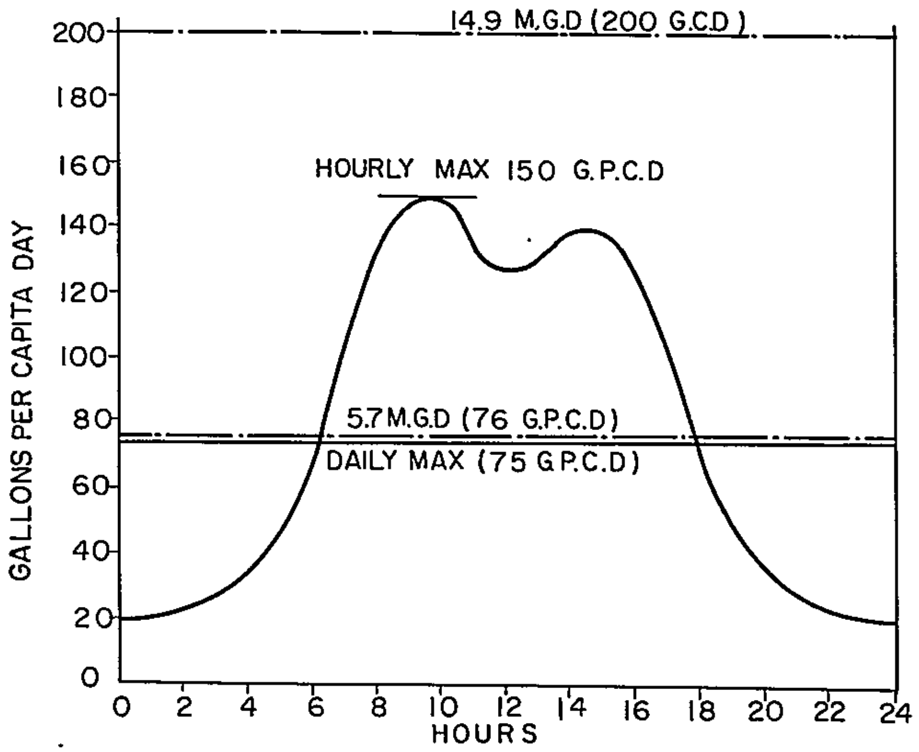



FIG 4.2-6 TYPICAL PATTERN OF HOURLY VARIATION ON PEAK DAY DEMAND



4.2.3 Water Demand

Estimated water demand in Islamabad is shown in Table 4.2-13 and Fig. 4.2-8.

In the drought season of 1969, the water production in May and June when the maximum day consumption occurred is shown as follows, which was taken from Table 3.2-1 and 3.2-3. It shows two data given by CDA and taken from daily discharge records of Korang Head Works and Simly Filtration Plant.

| Month | Data by CDA | Data from daily discharge record |
|---|---|---|
| May | 6.74 mgd | 8.19 mgd |
| June | 4.24 mgd | 7.22 mgd |

The data are only showing monthly discharge and it is not reliable. Considering other informations available, it seems to be safe to assume that the production capacity of existing facilities is only 4 or 5 mgd against maximum day demand.

As the maximum day demand in 1970 is estimated at 11.25 mgd by Table 4.2-13, the existing production capacity is not sufficient.

It is recommendable therefore to begin the construction of Simly Dam and provide 24 mgd of water supply as soon as possible, but it requires three years for the dam construction works and water supply will be started only in 1973. The water supply of 5 mgd from the existing water sources will be quite short for three years up to that time when water can be supplied by Simly Filtration Plant in its full capacity. To meet such urgent requirement, the rehabilitation works to minimize the wastage become very urgent.

According to the plan envisaged, the Simly Filtration Plant will supply water for the demand upto 1979 and Khampur Filtration Plant where 45 mgd of water is to be taken from Khampur should supply water for the demand after 1979. To complete the proposed Khampur Filtration Plant on time, planning and designing of the plant should be begun around 1975, in order to meet water demand in 1979.

Table 4.2-13

Estimated Water Demand

| Year | Served population | Average day demand | | Maximum day demand | |
|---|---|---|---|---|---|
| | | gpcd | mgd | gpcd | mgd |
| 1970 | 75,000 | 100 | 7.5 | 150 | 11.25 |
| 1975 | 150,000 | 95 | 14.25 | 143 | 21.45 |
| 1980 | 225,000 | 90 | 20.25 | 135 | 30.38 |
| 1985 | 400,000 | 90 | 36.00 | 135 | 54.00 |
| 1990 | 512,000 | 85 | 43.52 | 128 | 65.54 |
| 1995 | 638,000 | 85 | 54.25 | 128 | 81.69 |
| 2000 | 768,000 | 85 | 65.25 | 128 | 98.26 |

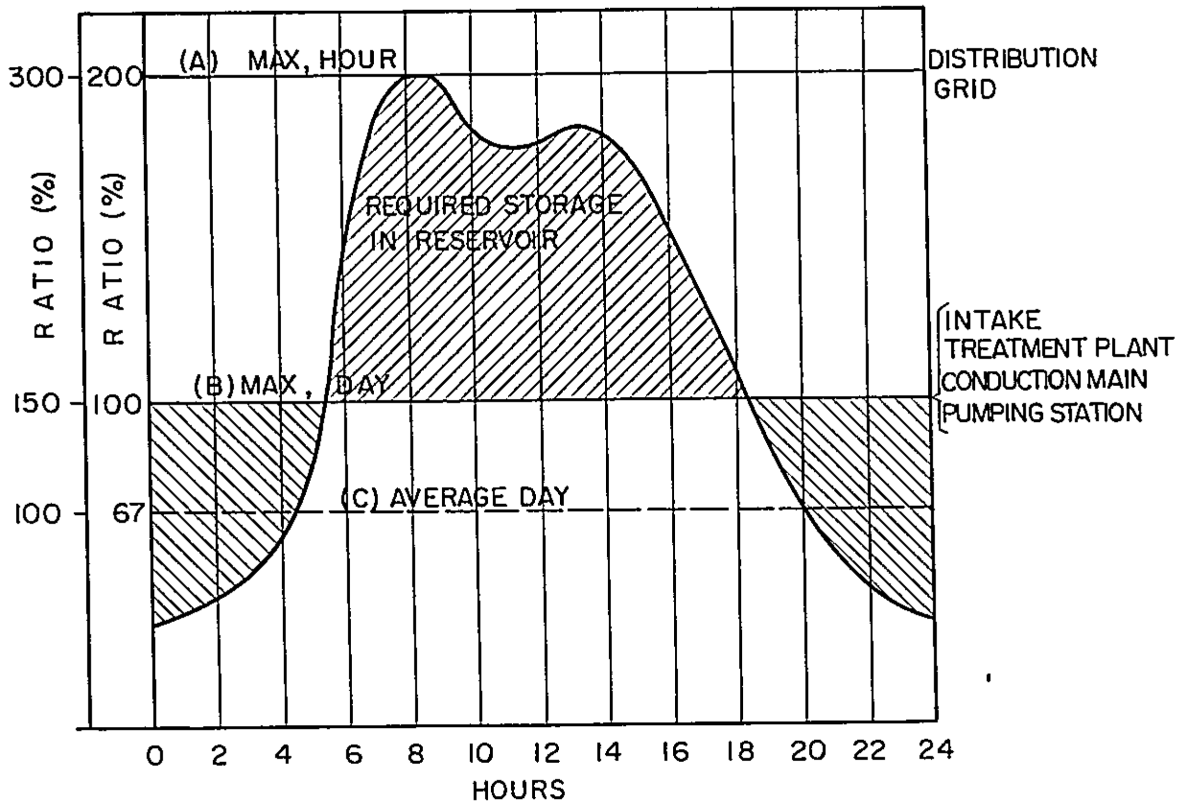
### 4.2.4 Design Criteria

A typical curve of hourly variation in the maximum day demand is shown in Figure 4.2-6. To ensure an adequate supply at all time, it is recommended that the pipes should be designed for the maximum hour demand and that the treatment plant for the maximum day demand. The reservoir for regulating the maximum day demand and maximum hour demand should also be provided for the quantity above the maximum day demand. The other remaining criteria are shown as below:

| Name of Facilities | Design Criteria |
|---|---|
| (Dam) | Average day demand |
| Intake | Maximum day demand |
| Treatment plant | " |
| Conduction main | " |
| Pumping st. | " |
| Reservoir | Maximum day/Maximum hour demand |
| Distribution grid. | Maximum hour demand |

FIG4.2-7 SHOWING RELATION OF WATER CONSUMPTION AND DESIGN CRITERIA FOR WATER SUPPLY PROJECT

(ASSUMED TYPICAL HOURLY VARIATION)



## 4.3 Water Supply System

So far, basic matters which dominate the planning of water supply have been studied and discussed. Now, based upon the findings and results of above discussions, a profile of a new water supply system to be constructed has been drawn out, and it is briefly summarized in this section. (see the details of the program are given in the succeeding sections)

It is obvious that potable water supplied from the existing head works is extremely short as shown in Fig. 4.2-8.

The way out of the severe scarcity of water is that the construction of Simly Dam is done as soon as possible and the Simly Filtration Plant supplies water to Islamabad with its full capacity of 24 mgd.

When the works for the construction of Simly Dam is started within 1970, the water of the full capacity 24 mgd from Simly Filtration Plant will be able to be supplied around 1973, for about 200,000 population.

As regards the existing head works after completion of Simly Dam, it is advisable that, since all of them are small in their capacity, they are to be kept for the emergency use for Simly Filtration Plant, especially Golf Course Head Works and G-10 Head Works supply water mainly for construction activities and also for sprinkling public green space without any special maintenance. Such arrangement will be useful as the population in Islamabad is estimated at 200,000 in 1979, and full capacity of Simly Filtration Plant may only meet the demand 24 mgd of that year.

After 1979, a new water supply of 45 mgd is expected to be acquired from the Khampur project. The water of 45 mgd is to be taken at the Margala Pass on the left bank canal for irrigation of Khampur Project.

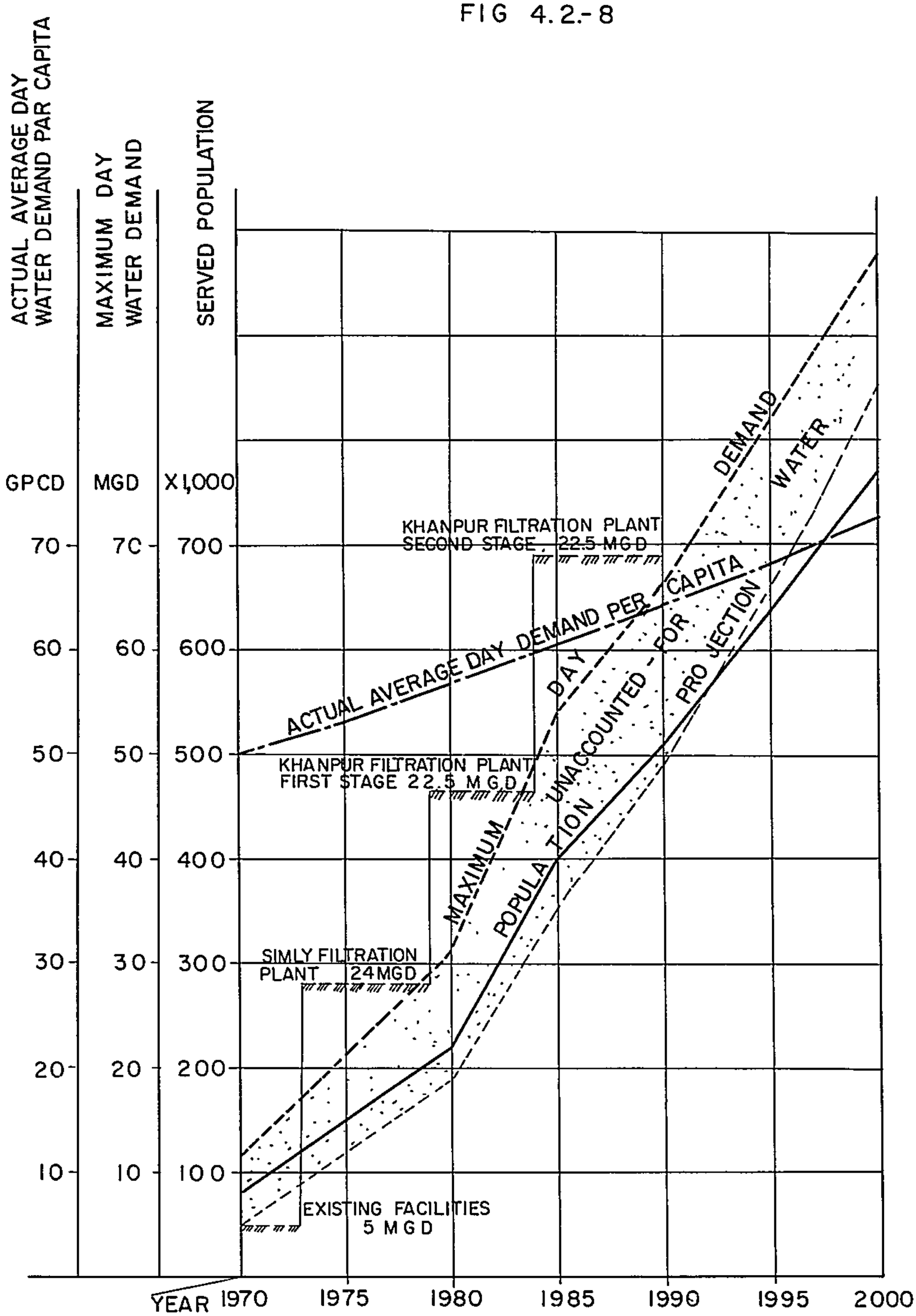
The proposed Khampur Filtration Plant should start to supply water in 1979 for increased population after 1981. The planning and design of this plant are necessary to start around 1974 for its completion before 1979.

The proposed plant will have a capacity of 45 mgd and it will be divided into two parts with the capacity of 22.5 mgd, one part starting to supply water by 1979 and the other by 1984.

Based on the population projection, the population increase up to 1992 will be supplied water from the existing Simly Plant and the proposed Khampur Filtration Plant. However, after 1992, new water sources should be developed for the increased population.

As far as the distribution pipes are concerned, as each sector shall be developed according to the plan by Planning Directorate, CDA, distribution pipes should be laid in advance of the scheduled time. The design criterion of distribution pipes above is based on maximum hour consumption mentioned in paragraph 4.2.4 Design Criteria and shown as follows:

FIG 4.2.-8


ACTUAL AVERAGE DAY WATER DEMAND PAR CAPITA
MAXIMUM DAY WATER DEMAND
SERVED POPULATION
GPCD
MGD
X1,000
70
60
50
40
30
20
10
70
60
50
40
30
20
10
700
600
500
400
300
200
100
KHANPUR FILTRATION PLANT
SECOND STAGE 22.5 MGD
KHANPUR FILTRATION PLANT
FIRST STAGE 22.5 MGD
SIMLY FILTRATION
PLANT 24MGD
EXISTING FACILITIES
5 MGD
ACTUAL AVERAGE DAY DEMAND PER CAPITA
MAXIMUM DAY DEMAND
POPULATION PROJECTION
UNACCOUNTED - FOR WATER
YEAR
1970
1975
1980
1985
1990
1995
2000

| Year | Max. hour demand<br>Average day demand | Max. hour demand<br>per capita |
| --- | --- | --- |
| 1970 | 300% | 300 gpcd |
| 1980 | 300% | 270 gpcd |
| 1990 | 275% | 233.75 gpcd |
| 2000 | 250% | 212.5 gpcd |

Considering above figures, 212.5 gpcd should be used as design criterion for distribution mains only. The distribution pipes which form subsidiary grid in the individual sectors should be designed on basis of maximum hour demand in the year when they are fully developed. And furthermore water supply service area should be divided into high, middle and low service areas each with 115 feet of working pressure on the basis of topographical contour line and location of reservoirs.

To summerize the above in the order of work schedule:

-- Rehabilitation Works (1970)

Before the completion of Simly Dam, the urgent program should be taken up. The most important work in this program is that nearly 50 percent of leakage in the existing water supply system should be prevented. The major work is to repair the existing Simly Conduction Main and the distribution pipes in the city. And secondly it is also very important to survey for the second line of proposed Simly conduction main and to review of the existing drawings of the distribution pipes for maintenance and future expansion.

-- First Stage Works (1971-1980)

Simly Dam should be constructed by 1973. The second line of Simly conduction main should be constructed before 1973.

Distribution pipes in developed sectors F-6, G-6, F-7, G-7 and developing sectors E-7, E-8, F-8, E-9, F-9, should be laid in the first stage.

The population in 1979 may be 200,000 and Simly Filtration Plant with the capacity of 24 mgd will be able to supply water of maximum hour demand for the entire population.

-- Second Stage Works (1981-2000)

The proposed treatment plant and reservoirs should be constructed and distribution pipes laid to meet the demand of the increased population.

Served population in 2000 may be 768,000. New water sources should be developed to meet the demand of the increased population after 1992.

The distribution mains are designed to convey water to each sector along the periphery of sectors and to form networks as shown in Fig. 4.3-1. The minimum hydraulic pressure available at any points in the grid system would be normally 50 feet.

The distribution pipes in the individual sector would form subsidiary grid and ensure supply of water to the fire hydrants as well as adequate supply to the consumers.

Diameters of 40", 36", 24", 18", 12", 10" and 8" of pipes for distribution mains and diameter of 10", 8", 6", 4" and 3" of pipe for distribution pipes are proposed.

Four kinds of pipes i.e. ductile iron pipes and cast iron pipes with mechanical joint or slip-on joint, asbestos cement pipes with slip-on joint and P.V.C. pipes with solvent joint are proposed to be used for keeping the leakage below 15%. Under roads with heavy traffic, ductile iron pipes and cast iron pipes are recommended.

## 4.4 Rehabilitation Works

### 4.4.1 Simly Transmission Main

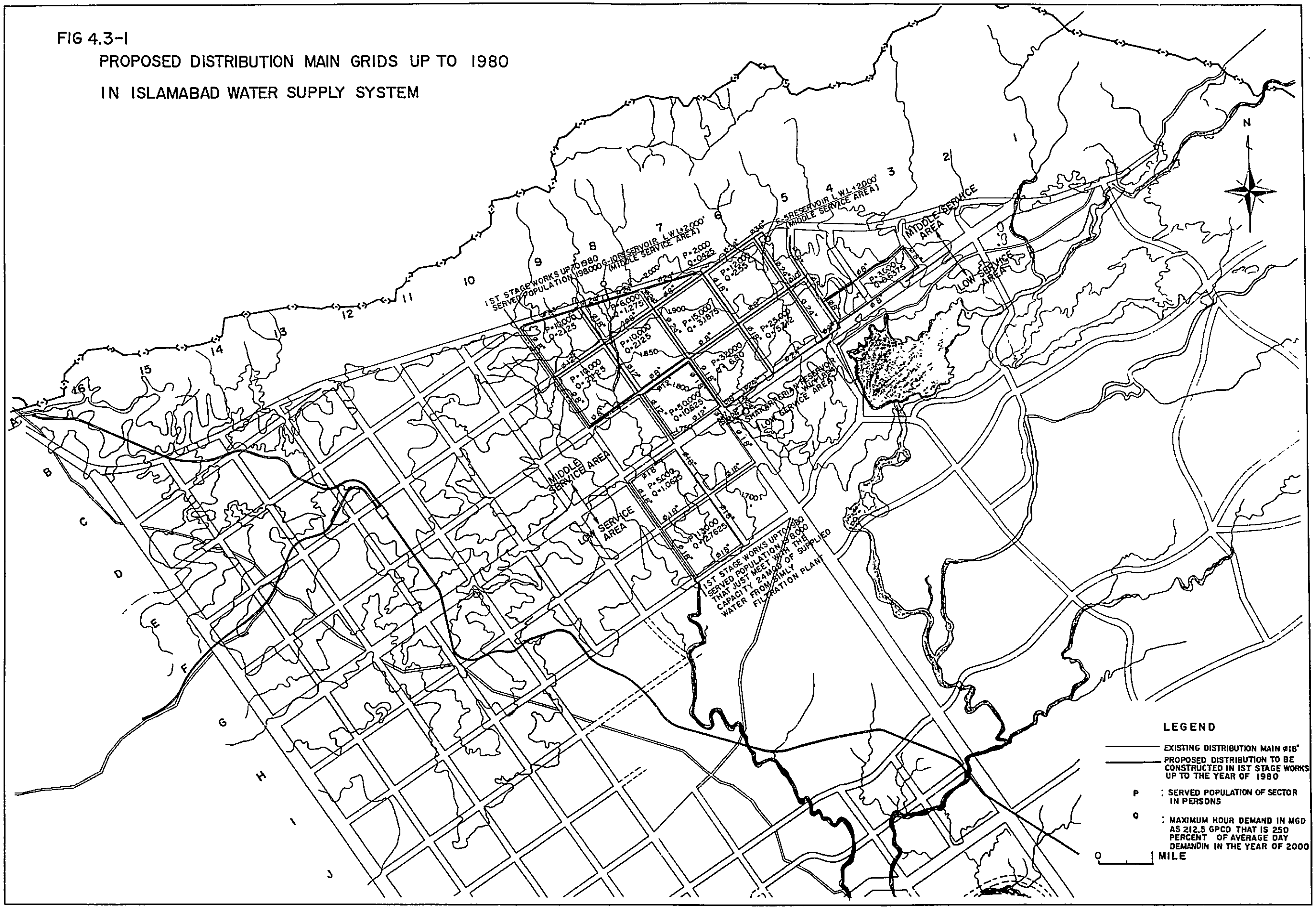
Details of the present condition of the Simly Transmission Main are already described in paragraph 3.1.5 Transmission Main. Water leakage is found abnormally high on the conduction main. Since a conduction main has no branches, leakage usually remains at a few per cent. In the case of the Simly Transmission Main,however, clear water equivalent to about 50% of the total flow is leaking. It is the most urgent work to repair the conduction main against such abnormal leakage.

It is found from the hourly pressure record at Gumureh Kas valve pit which is shown in Table 4.4-1, that the surge relief valve is kept open to release clear water during 34 hours out of 60 hours of operation. This ∅6" surge relief valve is designed to open and release water when the water pressure exceeds 150 psi. but pressure reduction will remain without significant change even if water flowing in the ∅36" pipe is released by the ∅6" valve.

As the most urgent work of rehabilitation program, it is recommended to replace a span 100 feet, of Simly Transmission Main at Gumureh Kas point with ductile cast iron pipes. The proposed new pipes should be such that will withstand a water pressure of 450 feet plus water hammer, 33% of the pressure assuming a valve closing time of 90 seconds.

A special jointing method of the proposed pipes with the existing

FIG 4.3-1
PROPOSED DISTRIBUTION MAIN GRIDS UP TO 1980
IN ISLAMABAD WATER SUPPLY SYSTEM



PRCC pipe is shown in Fig. 4.4-1.

Accordingly, neither a surge relief valve nor a stop valve will be required but only a drain valve will have to be installed at Gumureh Kas. Ductile cast iron pipes are to be jointed mechanically.

About 20 points of water leakage that were detected during the field investigation may have been caused by incomplete joints of pipes. It thus is recommended to protect the joints from leakage by covering them with specially designed caps made of rubber and steel plate.

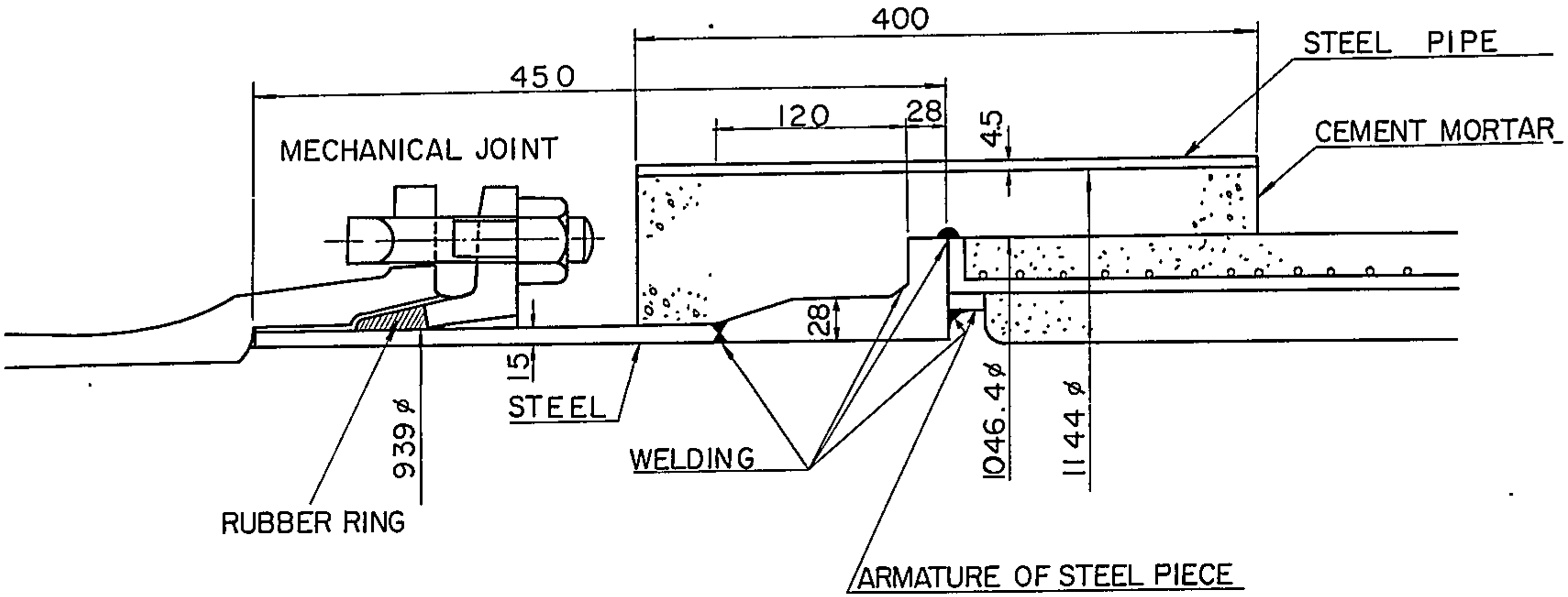
Table 4.4-1

Hourly Pressure Recorded at Gumureh Valve Pit in 1970

Unit: psi

| Hour \ Date | March 3rd | March 4th | March 5th |
|---|---|---|---|
| 4.00 | 140 | 150 | 145 |
| 6.00 | 140 | 145 | 145 |
| 8.00 | 145 | 145 | 145 |
| 10.00 | 150 | 155 | 150 |
| 12.00 | 150 | 155 | 155 |
| 14.00 | 150 | 145 | 145 |
| 16.00 | 145 | 145 | 160 |
| 18.00 | 145 | 145 | 150 |
| 20.00 | 150 | 150 | 145 |
| 22.00 | 145 | 145 | 145 |

FIG 4.4-1
DESIGN OF STEEL JOINT FOR CONNECTION OF NEW DUCTILE CAST IRON PIPE AND THE EXISTING P.R.C.C PIPE




WEIGHT------213 kg (APPROXIMATE)

LENGTH IN MM

4.4.2 Distribution Pipe

PRCC pipes have been used for ø18" and ø15" diameter of distribution mains, while the distribution pipes branching from the mains are cast iron pipes with bell-and-spigot lead joints. Water leakage from these distribution pipes is mainly caused by incomplete backfilling when they were laid, resulting in irregular settlement and loose joints. Therefore, it is necessary to recaulk each lead joint.

Valves responsible for the greater part of visible leakage detected should be repaired. It is estimated that about 500 numbers of valves have been installed ranging from ø3" to ø10". Of them, it would be necessary to replace half of them with new valves and, for the remaining half, to remove their spindles and cover the spindle holes with specially designed caps to discard the valve function and stop water leakage completely, as shown in Fig. 4.4-2.

Also, it is recommended to use PVC pipe, asbestos cement pipe with sleeve and rubber rings and cast iron pipe with slip-on bell-and-spigot joint for ø3"-ø12"distribution pipes, and ductile cast iron pipe with mechanical joint for ø18" or larger diameter of distribution pipes. Use of PRCC pipes must be avoided.

Reducing the number of sizes of pipes to ø3", ø4", ø6", ø8", ø10", ø12" and ø18" diameters are recommended for use and the number of types of valves, specials and fittings would then be saved.

4.4.3 Water Meters and Meter Shop

As the result of investigation of existing water meters (see 3.4 The Existing Water Meters), it was found that they cannot be operated for a long time unless partially modified. A money-saving method of such modification or improvement is to fabricate new pinion drive wheels and install these in the existing water meters. However, practically it is recommended to replace the entire gear mechanism in the register box containing pinion drive wheels.

If gear mechanisms are to be manufactured by K.K. Kimmon Seisakusho in Japan, the price of one unit of gear mechanism will be about US$3.00.

The existing meter shop is equipped with only one testing tank apparatus but not with tools necessary for meter testing and small repair.

As the existing water meters will continue to fail, the meter shop should urgently be equipped with complete necessary facilities and tools (see Table 4.4-2), so that installed water meters will be replaced at regular intervals, while they are checked for accuracy and necessary small repairs are carried out. By doing so, the consumers will develop their confidence on water meter reading and thus the water charges can be collected without trouble with them.

FIG 4.4−2 SPECIAL CAPS DESIGNED FOR REPAIR OF EXISTING VALVES

FLANGED TYPE VALVE

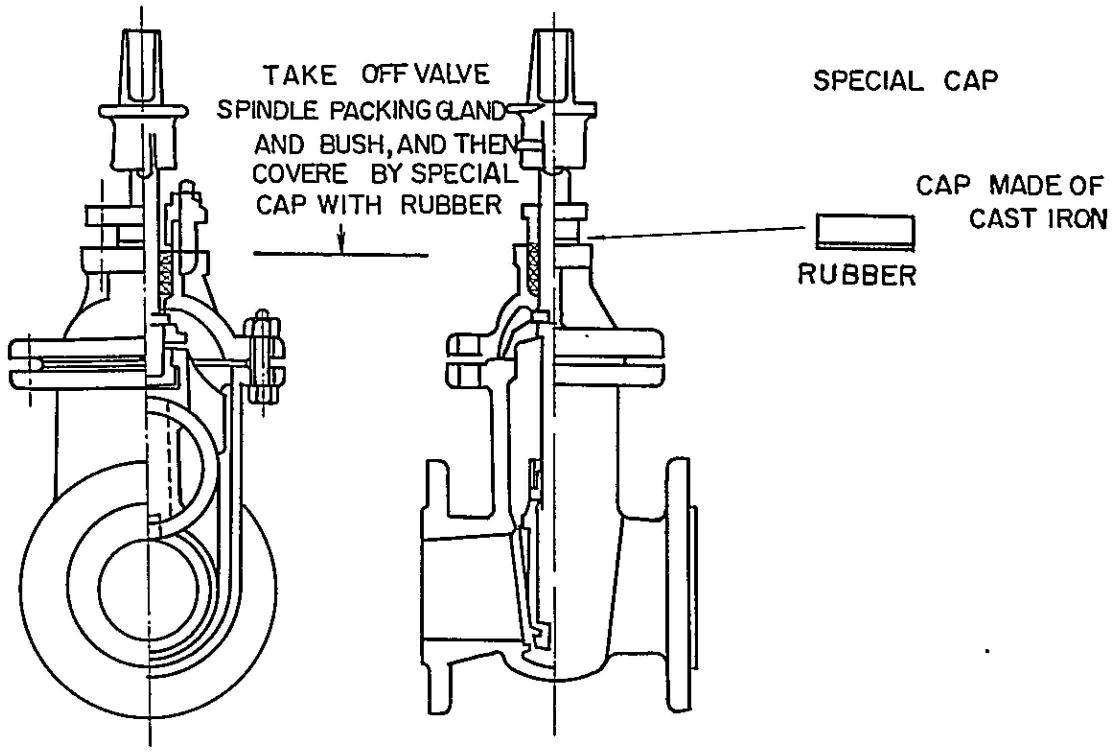


Table 4.4-2

Repair Tools & Others for Meter Shop

| S.N. | Name | Nos. | S.N. | Name | Nos. |
|---|---|---|---|---|---|
| 1 | Testing meter joint (13 mm - 40 mm) | 100 | 20 | Special wire brush | 10 |
| | | | 21 | Brass wire brush | 5 |
| 2 | Testing bases joint (13 mm - 30 mm) | 14 | 22 | Pivot driver | 6 |
| 3 | Bushing for strainer | 2 | 23 | Pincette | 4 |
| 4 | Single head spanner (13 mm - 30 mm) | 8 | 24 | Flat file 8", 10" | 4 |
| | | | 25 | File sets | 4 |
| 5 | Indicator box driver (13 mm - 40 mm) | 6 | 26 | Oaktree hammer | 4 |
| 6 | Testing U joint (13 mm - 40 mm) | 20 | 27 | Acid pickling basket | 4 |
| | | | 28 | Electric soldering iron (100W) | 1 |
| 7 | Letter punch | 1 | | | |
| 8 | Cutting nipper 7" | 2 | 29 | Vise | 1 |
| 9 | Pincers, 5", 7" | 4 | 30 | Bench drilling machine (1/3 rp) | 1 |
| 10 | Pillar driver | 2 | | | |
| | | | 31 | Polish machine 1 HP | 1 |
| 11 | Hair bruch | 2 | | | |
| | | | 32 | Leakage tester apparatus | 1 |
| 12 | Special box spanner | 6 | | | |
| 13 | Box spanner | 6 | 33 | Compressor 1 HP | 1 |
| 14 | Fan wheel regulation jig | 2 | 34 | Air gun and hose | 1 |
| | | | 35 | Meter holding bed | 1 |
| 15 | Screw driver 3"-8" | 9 | | | |
| | | | 36 | Test tank apparatus | 2 |
| 16 | Hammer 1/4 lbs, 1/2 lbs | 4 | | | |
| 17 | Fan wheel test rod | 2 | | | |
| 18 | Fan wheel test jig | 2 | | | |
| 19 | Wire brush | 10 | | | |

## 4.5 1st Stage Works

### 4.5.1 Simly Dam

In regard to selecting a site of a dam on the Soan river for the supply of water to Islamabad, studies have been carried out (in September, 1963) by CDA and consulting engineers.

The proposed scheme is to construct a dam at Simly in order to create a storage reservoir. The regulated flow from the reservoir will then be fed into a treatment plant which will be located immediately downstream of the dam site on the right bank of the river.

The main features of the scheme are finalized as follows:

i) Dam site and location: The dam site is selected at Simly approximately 14 miles from Islamabad and can be reached by road. It is located immediately down stream of the Simly village in a V-notch cut into an anticline of resistant sand stone.

ii) Reservoir and intake: The Soan river at Simly has a catchment area of 59 sq. miles and extends into the upper Murree upto elevation 7,000 feet above mean sea level. From the hydrological study, the sill of the intake has been set at elevation 2,220 feet. This delivery point is at an elevation which permits gravity supply of water to Islamabad.

The normal maximum operating level of the reservoir is 2,295 feet and at this level the impounding reservoir has an area of 420 acres and extends approximately 3 miles up stream.

Then the effective storage of reservoir is 19,800 acre-feet (24,400,000 $m^3$).

iii) Dam: The main characteristics of the dam are;

- An earthfill dam 250 feet high with a volume of about 3 million cubic yard.
- An overflow type spillway located at the left abutment, with a design discharge capacity of 45,000 cusecs.
- 6 feet diameter intake tunnel also located on the left abutment between the spillway and the dam.
- Minimum river bed elevation 2,075 feet
- Maximum water level 2,315 feet
- Elevation of the crest of the dam 2,325 feet

— Crest length 1,040 feet

— Crest width 35 feet

— Normal tail water level 2,085 feet

The diversion tunnel for construction of the Simly Dam is now under construction. Complementary investigations and tests are still being carried out in order to finalize certain details of the main structures of the scheme.

Then, in July, 1968, and temporary pumping plant was placed in operation, and water is treated at the plant and conveyed through a line of the planned twin pipelines to Islamabad.

In regard to the effective storage of reservoir the mass curve during the last three years is shown in Fig. 4.5-1. After completion of Simly dam, it is expected that the flood on the Soan river is controlled and surplus of water is utilized for irrigation. For the multiple purposes of not only potable water to Islamabad, but also flood control and irrigation, the construction of Simly dam should be started as soon as possible with utmost efforts.

It is felt that there are some problems in design of Simly Dam, which are described in Annex - 5.

FIG. 4.5-1 MASS CURVE OF SIMLY DAM

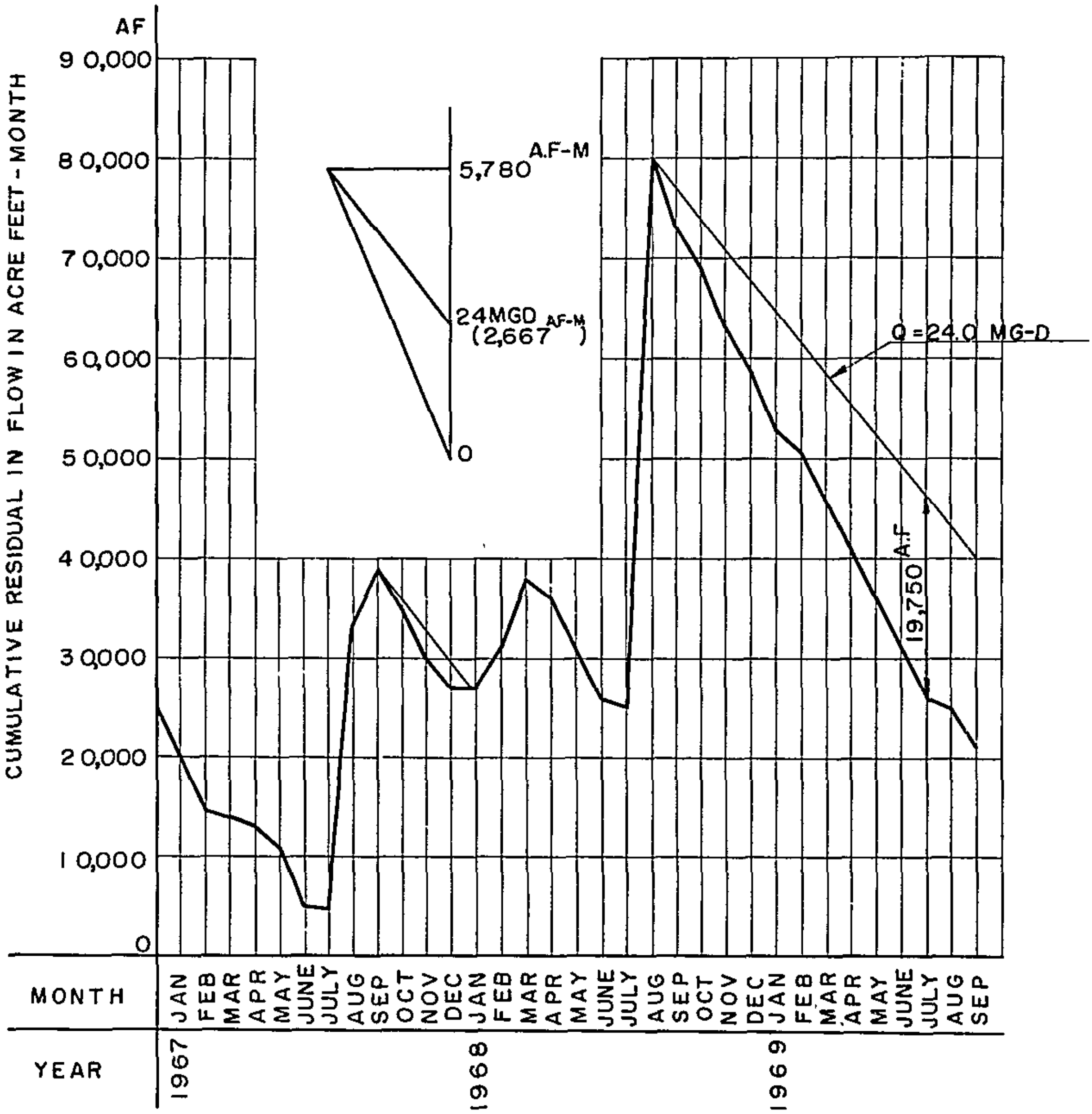
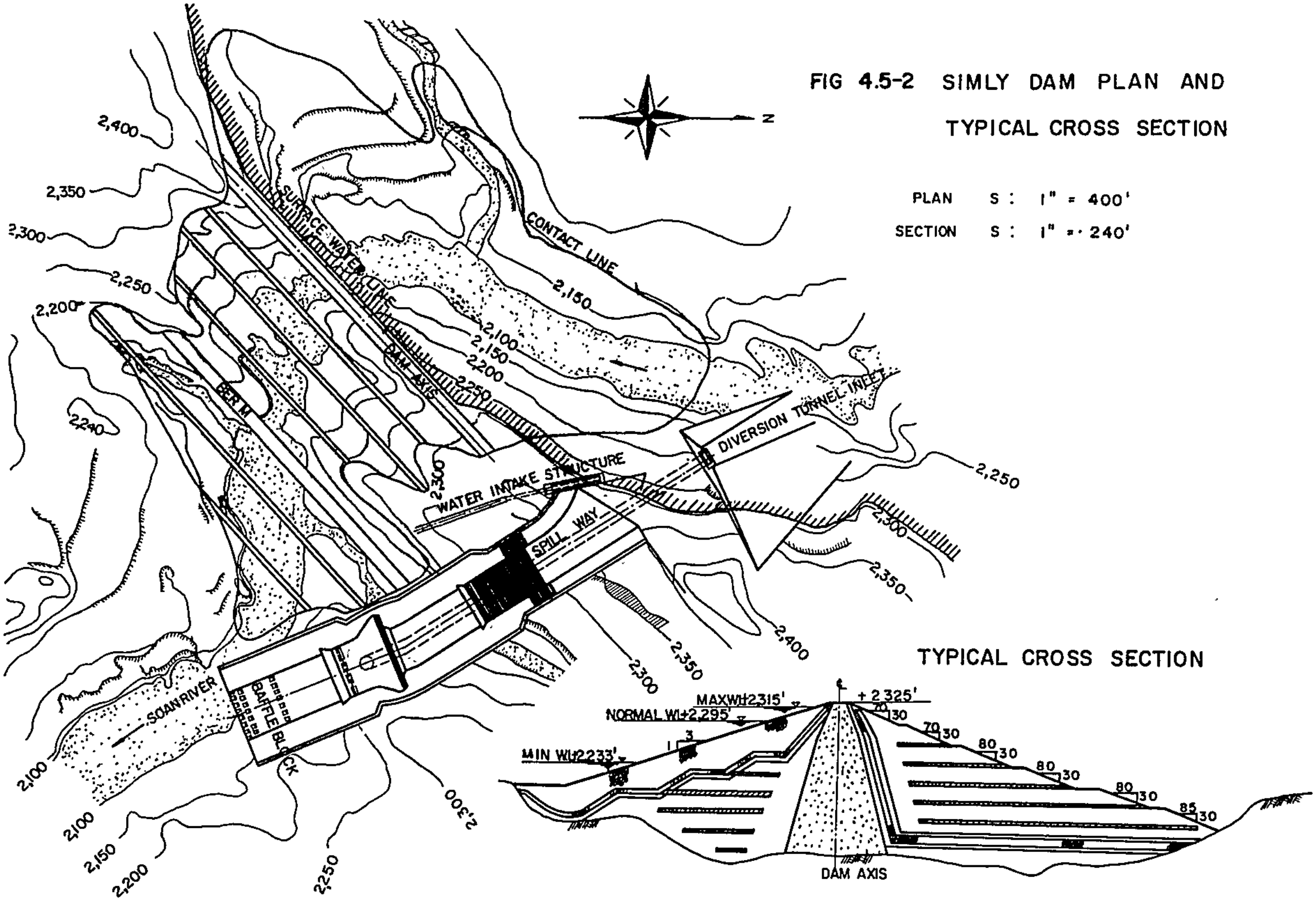


FIG 4.5-2 SIMLY DAM PLAN AND TYPICAL CROSS SECTION

PLAN S : 1" = 400'

SECTION S : 1" = 240'



### 4.5.2 Extension of Simly Transmission Main

(1) Discharge capacity

The final capacity of the Simly Transmission Main is 24 mgd (116,000 $m^3$/day). It is assumed that water will be conveyed through a ø36" (900 mm) PRCC pipeline to the proposed reservoir, and the capacity of the existing pipeline is calculated as 15 mgd. However, it will be appropriate to allot 12 mgd, half of the capacity, to the existing pipeline and 12 mgd for the extension for convenience of maintenance and operation. So the final shape of the main has two ø36" lines.

(2) Route of pipeline

Judging from the present Simly Transmission Main, it is proposed that the route of another pipe line shall be in parallel to the existing pipeline.

The existing pipeline has a route running practically along the pipeline road or public road, as described in paragraph 3.1.5. Therefore, the proposed extension work will probably be done without difficulty.

(3) Diameter of proposed pipe line

The pipe used for existing conduction line is ø36" diameter of PRCC pipe. CDA is laying an additional pipeline with the same materials. However, PRCC pipes have many technical problems and are not desirable for use as the proposed pipeline.

The existing 36" diameter PRCC pipe must be improved by rehabilitation works. The other line will be 36" diameter either of steel or ductile cast iron pipe and replace the PRCC line partially under construction (this line will be discarded) with new pipes.

The maximum discharge capacity of the two line will be about 25 mgd, with a normal flow discharge of 24 mgd.

For reference, characteristics of ductile cast iron pipes and steel pipes are described below:

(a) In material cost, the steel pipe is slightly lower. In installation cost, however, the steel pipe will be higher than ductile cast iron pipe because the former requires field welding.

(b) The ductile pipe, after all, may require a cost about 10% higher than the steel pipe.

(c) In the case of steel pipes, equipments, workers for temporary installation of such equipments and skilled welders will be required for field welding jobs. But mechanical jointing may be easily done by plumbers.

(4) Selection of materials of pipes

The material of the pipe to be used on the proposed pipeline shall be either ductile cast iron or steel because of the following reasons:

(a) The pipeline is expected to have a maximum water pressure of 450 feet when crossing over Gumreh Kas River and has big differences in elevation because the expected route has many ups and downs. These may cause water hammering in the pipeline. DCIP or steel pipes will assure higher safety because it can withstand high pressure.

(b) Pipe joints should be easily made and have reliable functions. This requirements can be met by ductile cast iron pipe with mechanical joint and steel pipe with welding joint.

(c) The PRCC pipe used on the Simly Main cannot fulfil the requirements in both strength and mechanism of joint as described in paragraph 3.1.5.

4.5.3 Distribution System of Simly Filtration Plant

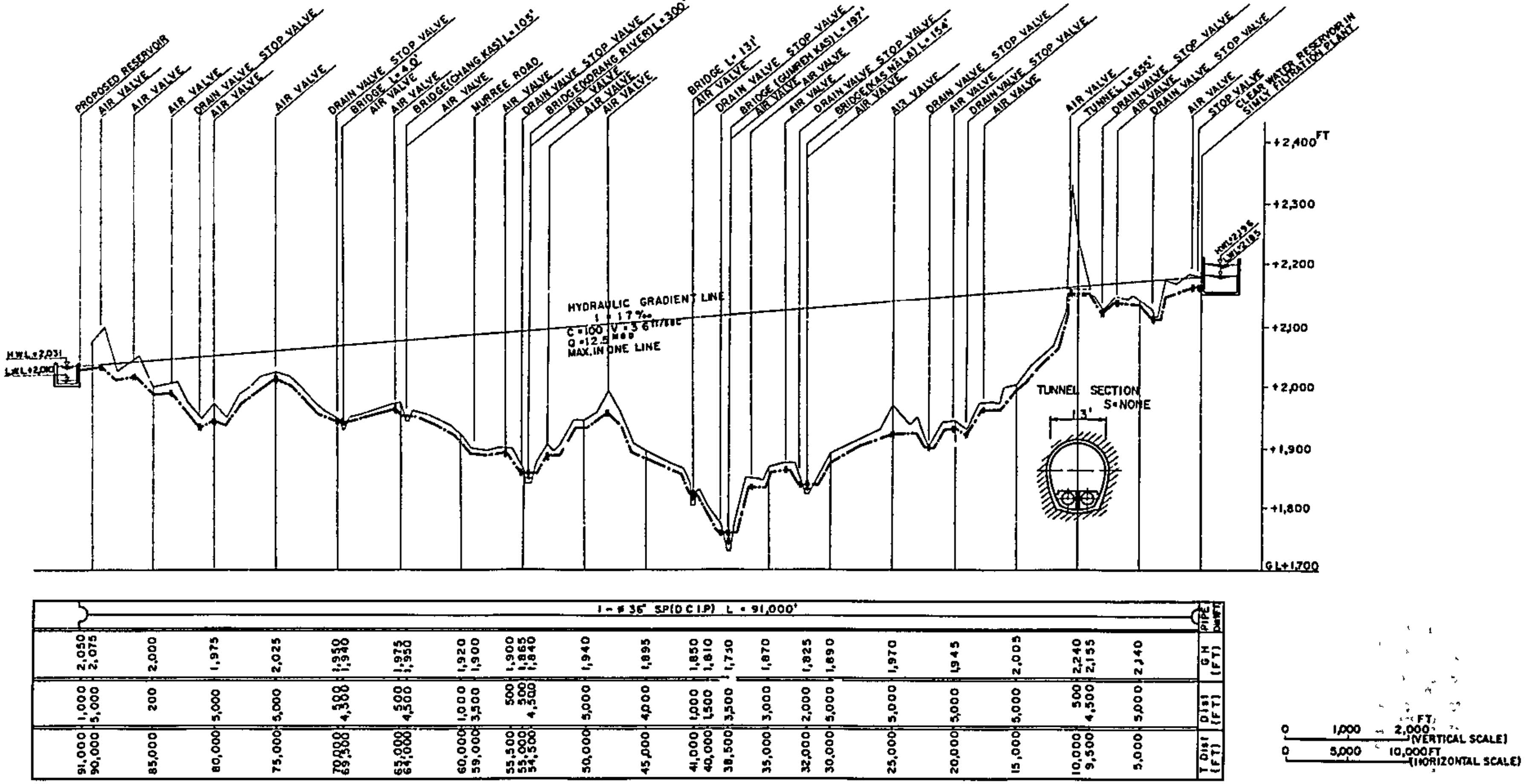
The capacity of the existing Simly Filtration Plant after completion of Simly Dam is 24 mgd. As the estimated maximum day demand per capita in 1980 is 135 gpcd, the population served by Simly Filtration Plant is calculated as 179,100. In 2000 with the estimated maximum day demand per capita of 128 gpcd, the population of 187,500 would be supplied water of 24 mgd from Simly Filtration Plant.

The population in the middle service area to be supplied water from Simly Filtration Plant is 125,000 persons in 1980. As the ultimate population in this area is 125,000 persons, the capacity of Simly Filtration Plant to supply to the low service area besides the middle service area is 16.75 mgd at maximum day demand 135 gpcd in 1980 and 8 mgd at maximum day demand 128 gpcd in 2000. It is obvious that the design of connection pipe from the middle service area of Simly water supply system to Shakarperian Reservoir should be based on the capacity to convey 16.75 mgd.

However, the distribution mains to be laid in the first stage works upto 1980 should be designed to be able to convey maximum hour demand of 212.5 gpcd in 2000.

In the low service area, at sectors H-9 and I-9, the distribution mains of PRCC pipes with 18" diameter have already been laid.

FIG. 4.5-3 PROFILE OF PRPOSED TRANSMISSION MAIN



And also in the sectors F-6, F-7, G-6 and G-7 out of the middle service area supplied water from Simly Filtration Plant, the distribution pipes consisting of PRCC pipes and cast iron pipes with 3" upto 18" diameters have been laid.

The grids of distribution mains in the middle service area are calculated by Hardy Cross Method with Hazen-Williams formula using the electronic computer and the results are shown in Table 4.5-1 and Fig. 4.5-4.

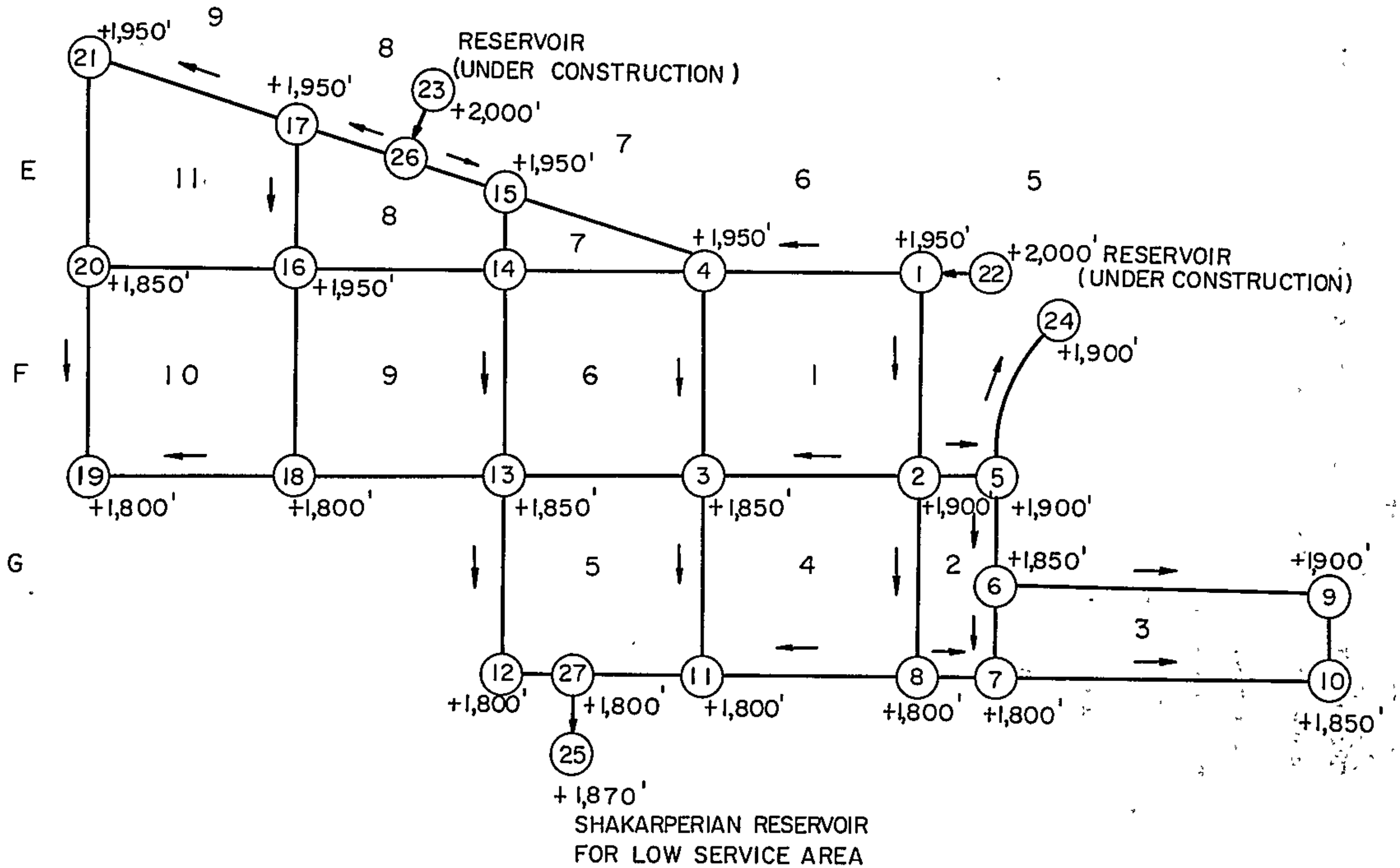
The diameters and length of distribution mains which are to be laid as first stage works in the middle service area are shown as follows:

| Diameter in inches | Length in feet |
|---|---|
| 36" | 10,000 |
| 24" | 45,000 |
| 18" | 32,000 |
| 12" | 13,000 |
| 10" | 3,000 |
| 8" | 85,000 |
| Total | 188,000 |

As far as the distribution pipes in the service area mentioned above as 1st stage works are concerned, necessary pipes are only for developing areas with a population of roughly 50,000 persons.

The total length of the distribution pipes with diameter of 3 inches upto 10 inches in above service area is estimated as 150,000 feet on the basis of the data from the cities with same population in Japan.

FIG 4.5-4 MAIN GRID OF MIDDLE SERVICE AREA IN SIMLY WATER SUPPLY SYSTEM



## TABLE 4.5-1

### Results of Hydraulic Calculation of Distribution Main Grid in the Middle Service Area

Trial calculation

Total loss head of each nets in feet

| NET NO | Trial times | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII |
| 1 | -0.86335 | 0.01982 | -000316 | -000098 | -0.00151 | -0.00006 | -000000 | 000000 |
| 2 | 2.4730 | -0.45955 | 0.00488 | -0.00006 | -0.00001 | -0.00000 | 0.00000 | -0.00000 |
| 3 | -0.30374 | 0.00183 | -0.00286 | -0.00002 | -0.00000 | -000000 | 000000 | -0 00000 |
| 4 | -12.186 | 034361 | -0.00435 | -0.00056 | -0.00319 | -000078 | -0.00003 | -0.00000 |
| 5 | -3.9558 | 3.1239 | 1.0239 | 0.53481 | -1.7966 | -0.27199 | -0.01398 | -000004 |
| 6 | 1 1102 | -395 50 | -93.326 | -21.801 | -2.7158 | -0.39305 | -0.01704 | -000003 |
| 7 | -3.7602 | 393.17 | 92.591 | 21.334 | 45233 | 066859 | 003122 | 0.00008 |
| 8 | 5.5358 | -3.7315 | -0.36286 | 002249 | 000054 | 0.00019 | 0.00000 | 0.00000 |
| 9 | 0.94611 | 47905 | 028754 | 0.00139 | 0.00187 | -000336 | -0.00010 | 0.00000 |
| 10 | 0.21089 | -0.11712 | 0.01562 | -0.00001 | -0.00012 | 000025 | 0.00000 | 0.00000 |
| 11 | 4.4707 | -2.7150 | -0.14986 | -0.00056 | -000000 | -0.00000 | 0.00000 | 0.00000 |
| 12 | -1.2620 | -18824 | -0.42247 | -0.09110 | -0.01161 | -0.00478 | 0.00025 | 0.00000 |

Index

C : coeficient of roughness of pipe
D : nominal diameter of pipe
Q : quantity of water
I : hydraulic gradient
L : length of pipe line
HL : head loss
TH : total head loss
HW : water head
HG : ground height
H : residual water head

| NET:NO | CONNECTION | C | D (inch) | Q (cfs) | I (‰) | L (ft) | HL (ft) | TH (ft) | HW (ft) | HG (ft) | H (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 - 2 | 130 | 36 | 29.4 | 1.55 | 5905 | 9:18 | 14 | 1986 | 1900 | 86 |
| | 2 - 3 | 130 | 18 | 7.5 | 3.64 | 6561 | 23.94 | 38 | 1962 | 1850 | 112 |
| | 3 - 4 | 130 | 18 | -7.7 | -3.77 | 5905 | -22.28 | 16 | 1984 | 1925 | 59 |
| | 4 - 1 | 130 | 24 | -10.5 | -1.65 | 6561 | -10.84 | 5 | 1995 | 1950 | 45 |
| 2 | 2 - 5 | 130 | 10 | 1.6 | 3 83 | 2296 | 8.80 | 23 | 1977 | 1900 | 77 |
| | 5 - 6 | 130 | 8 | 0.9 | 3.76 | 3608 | 13.58 | 36 | 1964 | 1850 | 114 |
| | 6 - 7 | 130 | 8 | 0.3 | 0.549 | 2296 | 1.26 | 38 | 1962 | 1800 | 162 |
| | 7 - 8 | 130 | 8 | -0.2 | -0.277 | 2296 | -0 64 | 37 | 1963 | 1800 | 163 |
| | 8 - 2 | 130 | 24 | -16.6 | -3.89 | 5905 | -23.01 | 14 | 1986 | 1900 | 86 |
| 3 | 6 - 9 | 130 | 8 | 0.3 | 0.499 | 9842 | 4.92 | 41 | 1959 | 1900 | 59 |
| | 9 - 10 | 130 | 8 | 0.6 | 0.003 | 2296 | 0.01 | 41 | 1959 | 1850 | 109 |
| | 10 - 7 | 130 | 8 | -0.3 | -0.372 | 9842 | -3.67 | 38 | 1962 | 1800 | 162 |
| | 7 - 6 | 130 | 8 | -0.3 | -0.549 | 2296 | -1.26 | 36 | 1963 | 1850 | 114 |

| NET:NO | CONNECTION | C | D (Inch) | Q (cfs) | I (%o) | L (ft) | H·L (ft) | T H (ft) | H W (ft) | H G (ft) | H (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 2 — 8 | 130 | 24 | 16.6 | 3.89 | 5905 | 23.01 | 37 | 1964 | 1800 | 163 |
| | 8 — 11 | 130 | 24 | 13.9 | 2.81 | 6561 | 18.46 | 55 | 1944 | 1800 | 145 |
| | 11 — 3 | 130 | 18 | -6.7 | -2.96 | 5905 | -17.52 | 38 | 1962 | 1850 | 112 |
| | 3 — 2 | 130 | 18 | -7.5 | -3.64 | 6561 | -23.94 | 14 | 1986 | 1900 | 86 |
| 5 | 3 — 11 | 130 | 18 | 6.7 | 2.96 | 5905 | 17.52 | 55 | 1945 | 1800 | 145 |
| | 11 — 27 | 130 | 24 | 15.1 | 3.25 | 3937 | 12.80 | 68 | 1932 | 1800 | 132 |
| | 27 — 12 | 130 | 18 | -5.0 | -1.70 | 2296 | -3.91 | 64 | 1936 | 1800 | 136 |
| | 12 — 13 | 130 | 18 | -8.1 | -4.19 | 5905 | -24.77 | 40 | 1960 | 1800 | 110 |
| | 13 — 3 | 130 | 8 | -0.2 | -0.279 | 5905 | -1.65 | 38 | 1962 | 1850 | 112 |
| 6 | 4 — 3 | 130 | 18 | 7.7 | 3.77 | 5905 | 22.28 | 38 | 1962 | 1850 | 112 |
| | 3 — 13 | 130 | 8 | 0.2 | 0.279 | 5905 | 1.65 | 40 | 1960 | 1850 | 110 |
| | 13 — 14 | 130 | 24 | -13.3 | -2.57 | 6233 | -16.05 | 23 | 1977 | 1850 | 52 |
| | 14 — 4 | 130 | 8 | -0.5 | -1.33 | 5905 | -7.88 | 16 | 1984 | 1925 | 59 |
| 7 | 4 — 14 | 130 | 8 | +0.5 | +1.33 | 5905 | 7.88 | 23 | 1977 | 1925 | 52 |
| | 14 — 15 | 130 | 24 | -15.6 | -3.45 | 2296 | -7.94 | 16 | 1984 | 1925 | 59 |
| | 15 — 4 | 130 | 24 | 0.6 | 0.009 | 6561 | 0.062 | 16 | 1984 | 1925 | 59 |
| 8 | 14 — 16 | 130 | 8 | -0.5 | -1.21 | 6233 | -7.59 | 16 | 1984 | 1925 | 59 |
| | 16 — 17 | 130 | 24 | -8.8 | -1.19 | 4265 | -5.10 | 11 | 1989 | 1925 | 64 |
| | 17 — 26 | 130 | 24 | -11.7 | -2.03 | 3608 | -7.34 | 3 | 1997 | 1925 | 67 |
| | 26 — 15 | 130 | 24 | 17.1 | 4.09 | 2952 | 12.08 | 16 | 1984 | 1925 | 59 |
| | 15 — 14 | 130 | 24 | 15.6 | 3.45 | 2296 | 7.94 | 23 | 1977 | 1925 | 52 |
| 9 | 14 — 13 | 130 | 24 | 13.3 | 2.57 | 6233 | 16.05 | 40 | 1960 | 1850 | 110 |
| | 13 — 18 | 130 | 8 | -0.2 | -0.222 | 6233 | -1.39 | 38 | 1962 | 1800 | 162 |
| | 18 — 16 | 130 | 12 | -2.6 | -3.56 | 6233 | -22.25 | 16 | 1984 | 1925 | 59 |
| | 16 — 14 | 130 | 8 | 0.5 | 1.21 | 6233 | 7.59 | 23 | 1977 | 1925 | 52 |
| 10 | 16 — 18 | 130 | 12 | 2.6 | 3.56 | 6233 | 22.25 | 38 | 1962 | 1800 | 162 |
| | 18 — 19 | 130 | 8 | 0.4 | 0.794 | 5905 | 4.69 | 43 | 1957 | 1800 | 157 |
| | 19 — 20 | 130 | 8 | -0.6 | -1.73 | 6233 | -10.79 | 32 | 1968 | 1850 | 118 |
| | 20 — 16 | 130 | 12 | -2.2 | -2.73 | 5905 | -16.14 | 16 | 1984 | 1925 | 59 |
| 11 | 20 — 21 | 130 | 8 | -0.4 | -0.655 | 6233 | -4.09 | 28 | 1972 | 1900 | 72 |
| | 21 — 17 | 130 | 10 | -1.3 | -2.61 | 6561 | -17.15 | 11 | 1989 | 1930 | 59 |
| | 17 — 16 | 130 | 24 | 8.8 | 1.19 | 4265 | 5.10 | 16 | 1984 | 1925 | 59 |
| | 16 — 20 | 130 | 12 | 2.2 | 2.73 | 5905 | 16.14 | 32 | 1968 | 1850 | 118 |
| 12 | 22 — 1 | 130 | 36 | 41.1 | 2.88 | 1640 | 4.73 | 5 | 1995 | 1950 | 45 |
| | 1 — 4 | 130 | 24 | 10.5 | 1.65 | 6561 | 10.84 | 16 | 1984 | 1925 | 59 |
| | 4 — 15 | 130 | 24 | -0.6 | -0.009 | 6561 | -0.06 | 16 | 1984 | 1925 | 59 |
| | 15 — 26 | 130 | 24 | -17.1 | -4.09 | 2952 | -12.08 | 3 | 1997 | 1930 | 67 |
| | 26 — 23 | 130 | 36 | -28.8 | -1.49 | 2296 | -3.43 | -0 | 2000 | 2000 | 0 |
| | 5 — 24 | 130 | 8 | 0.7 | 2.58 | 4921 | 12.73 | 35 | 1965 | 1900 | 65 |
| | 27 — 25 | 130 | 24 | 20.1 | 5.51 | 2296 | 12.66 | 81 | 1919 | 1870 | 49 |

## 4.6 2nd Stage Works (1981-2000)

### 4.6.1 Water Sources

(1) Khanpur Dam

Khanpur Dam is planned to be built on Haro River running below Khanpur village located about 16 miles (25 km) away north of Islamabad.

The main purpose of this dam is to develop a water source for both irrigation and drinking water for Islamabad. It is currently under construction by WAPDA (Water and Power Development Authority).

The Khanpur Dam is basically an earth fill dam having the main dam and four saddle embarkments whose major dimensions are shown in Table 4.6-1 below.

Table 4.6-1

Dimensions of Khanpur Dam

| | |
|---|---|
| Main Dam: | |
| Height above lowest foundation | 167 feet |
| Dam crest length | - |
| Dam crest width | 35 feet |
| Total embarkment volume | - |
| Spillway | Ungated free, overflow |
| Dam crest elevation | 1,992 feet |
| Dam foundations elevation | 1,825 feet |
| Impounding Reservoirs: | |
| Drainage area | - |
| Average annual precipitation | - |
| Average annual run-off | - |
| Live storage volume | - |
| Dead storage volume | - |
| Cross reservoir capacity | - |
| Highest surface water elevation | 1,982 feet |
| Highest surface water elevation | 1,900 feet |

(2) Left Bank Canal

Raw water taken from Khanpur Dam will be transmitted through two transmission systems; Right Bank Canal and Left Bank Canal. Water for Islamabad water supply will be transmitted through the Left Bank Canal. This canal runs from the intake gate installed on the saddle embarkment on the left bank of the main dam and down along Haro River to the west, crossing this river near Haro River Bridge, then turning towards the southwest and passing hills east of Taxila. The river then crosses Grand Trunk Road near Nicholson Monument and goes further towards the southwest. The branching point to Islamabad is expected to be near Grand Trunk Road right under Nicholson Monument.

The total length of Left Bank Canal from Khanpur Dam to this branching point is approximately 57,000 feet (17.5 km). According to the Khanpur Dam Project, approximate dimensions of the Canal at the branching point are as follows:

| | |
|---|---|
| Canal slope | 1/1,300 |
| Bed width | 4 feet |
| Depth of water | 3.35 feet |
| Discharge | |
| At upper side of branching point | 261 cu.ft./sec. |
| At lower side of branching point | 142 cu.ft./sec. |
| Canal bed level of branching point | 1,776 feet |
| Flow surface elevation of branching point | 1,779 feet |
| Velocity of water | 4.6 feet/sec. (1.4 m/sec.) |

Discharge at the branching point is 261 cusecs on the upper side and 142 cusecs on the lower side, as shown. The difference of 119 cusecs (290,000 $m^3$/day) between the upper and lower sides is considered to be diverted water at that point. Of the diverted flow, 84 cusecs (45 mgd) is to be used for Islamabad water supply.

4.6.2 Proposed Khanpur Treatment Plant

1. Basic Idea on Water Supply System

The purpose of this project is to treat raw water taken from Khanpur Dam through Left Bank Canal and supply the clear water to Islamabad at the rate of 45 mgd (200,000 $m^3$/day).

The following two alternative plans (A) and (B) are discussed below as the basic plans for the water supply system, with a view to plan most economical intake, transmission, treatment and pumping facilities.

Plan (A): The fundamental idea of this plan, as shown in Fig. 4.6-1, is to take raw water from Left Bank Canal passing near the boundary west of Islamabad and introduce the water by gravity to the treatment plant located adjacent to Grand Trunk Road in Sector C-16. Clear water which has been treated at the treatment plant is pumped up from the pumping station (inside the treatment plant) up to a reservoir on the hill in Sector D-13 and then is supplied by gravity to service areas.

Plan (B): The basic idea of this plan (B) as shown in Fig. 4.6-1, is to install a pumping station at the intake point as in Plan (A), pump raw water to a junction well on the hill east of the station and then introduce the water by gravity to the treatment plant at the same place as the reservoir site in Plan (A), clear water which has been produced at the plant will be supplied by gravity to each service area.

The essential difference in idea between Plans (A) and (B) is whether raw water is transmitted by gravity flow or pumped up to the treatment plant. Furthermore, Plan (A) may be preferable to Plan (B) because of the following reasons:

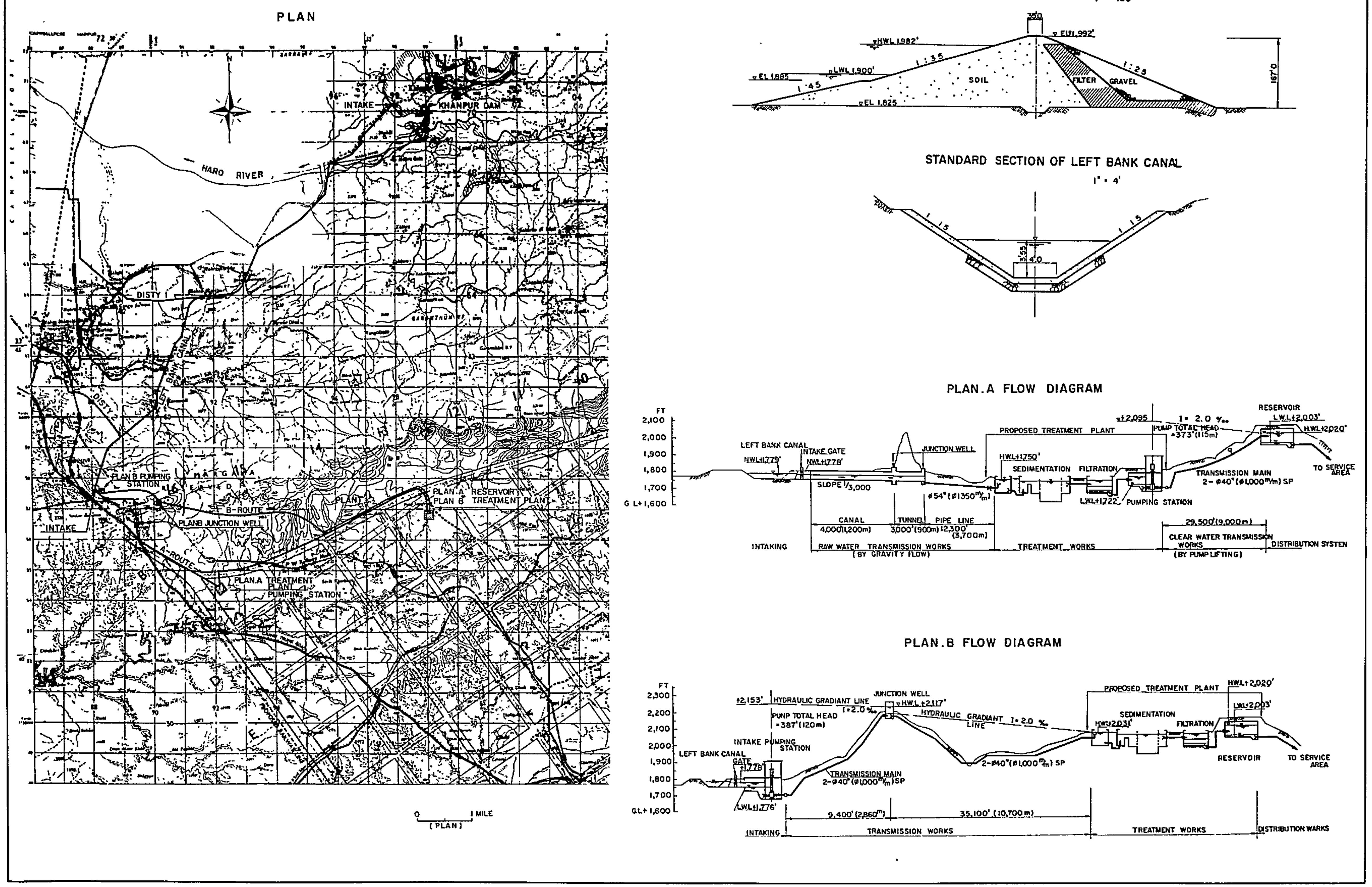
(1) Since water is taken and transmitted by gravity flow only, no pumping station is needed to be installed at the intake point. This means that the major facilities are not separated into the pumping plant and treatment plant, resulting in easier operation and maintenance.

(2) To pump water up to the same elevation, the total head of main pumps should be at least 373 feet (115 m) for Plan (A) and 387 feet (120 m) for Plan (B). Normally, water is wasted in the purification process at the treatment plant. Therefore, less clear water can be pumped up from the treatment plant. In this respect, Plan (A) is better because lower motor output is required.

(3) It is desirable for the durability of pumps to pump up clear water than raw water. This is because sand, soil or other impurities contained in raw water will cause the pumps and impellers to be worn more rapidly.

(4) The total distance of the transmission line of raw water and clear water is measured to be 48,500 feet for Plan (A) and 44,500 feet for Plan (B). The latter plan seems to be advantageous than the former. However with respect to the transmission system, a combination of open canal, tunnel and PRCC pipes is to be used for raw water under Plan (A) but it is necessary to use SP or DCIP for high pressure under Plan (B) since the water pressure on the pipe over the whole system in this plan must be high. Therefore, Plan (A) may be advantageous

FIG.4.6-1 PROPOSED KHANPUR WATER SUPPLY SYSTEM



in construction costs over the other. What is most important, Plan (A) permits raw water to be transmitted by gravity flow, maintaining stable supply of raw water, without interruption of the operation due to a failure of pump or power suspension.

(5) In the aggregate, Plan (A) may require lower construction costs than Plan (B).

(6) Plan (A) is clearly advantageous in control and maintenance of the water supply system over Plan (B). As discussed in the above (1) and (2), it is possible for Plan (A) to concentrate all functions to the treatment plant only, resulting in easier management of the facilities and at the same time less costs ancillary to them.

2. Design Capacity

The design capacity of the Khanpur water supply works has been set to 45 mgd (200,000 $m^3$/day) on the basis of the quantity available from Left Bank Canal. From the future water demand, the design capacity for the Khanpur system should be fixed as following phase.

| Phase | Design Capacity | Target Year for Completion |
|---|---|---|
| 1 | 22.5 mgd | 1979 |
| 2 | 22.5 mgd | 1984 |

From the above phasing program, it is considered that all necessary installations will be completed in two phases. Some of the facilities, however, may be technically undesirable and/or uneconomical if they are separated into two phases. In such a case, construction in one phase may have to be considered.

Table 4.6-2

Construction Schedule on Khanpur Project

| Works | Particular | Quantity | Phasing | | Remarks |
|---|---|---|---|---|---|
| | | | 1st stage | 2nd stage | |
| Intake | Intake facilities | 1 unit | 1 unit | - | |
| Raw water | Canal | 2,000 feet | 2,000 feet | - | |
| | Tunnel | 5,000 feet | 5,000 feet | - | |
| | Transmission pipe | 12,000 feet | 12,000 feet | - | |
| | Receiving well | 1 No. | 1 No. | - | |
| | Sedimentation | 2 units | 1 unit | 1 unit | |
| | Filter basin | 16 Nos. | 8 Nos. | 8 Nos. | |
| Treatment | Washing tank | 1 No. | 1 No. | - | |
| | Sludge basin | 1 No. | 1 No. | - | |
| | Clear water reservoir | 1 No. | 1 No. | - | |
| | Main building | 1 No. | 1 No. | - | |
| Clear water | Pumping station | 1 unit | 1 unit | - | |
| | Main pump | 6 Nos. | 3 Nos. | 3 Nos. | |
| | Transmission main to reservoir | 2 line | 1 line | 1 line | Distance of pipe line is 29,500 feet |

3. Intake and Raw Water Transmission Works

A. Intake Facilities

An intake basin will be connected at right angle with Left Bank Canal, with a trash screen and a sluice gate provided. The width and length of intake basin is 15 feet and 40 feet, respectively, with a separation wall located in the center. Each separated basin is provided with a screen and a sluice gate at the end of the intake basin. The screen is to remove floating matters. The gate is opened by hand. The normal depth of water is 4 feet. See Fig. 4.6-2.

B. Raw Water Transmission Main

As shown in Fig. 4.6-3 Flow Diagram (Plan A), the transmission line consists of an open canal, a tunnel and a pipeline. The tunnel must be provided for passing through the hill near the boundary at the west end of Islamabad. To reduce its cross section, it is planned to use the horse shoe shape. The tunnel will be advantageous over the pipe because the former has a lower hydraulic gradient.

There are many ups and downs on the ground and many crossings on rivers in the route from the terminal of the tunnel to the proposed treatment plant. With these taken into consideration, it is better to use pipes.

The total distance of the transmission system is 19,300 feet (5,800 m) as shown in Fig. 4.6-3, which consists of the following:

| | Distance | Dimensions |
|---|---|---|
| Open canal | 4,000 feet (600 m) | 7' x 5' concrete structure |
| Tunnel | 3,000 feet (1,500 m) | 7' horseshoe section |
| Pipeline | 12,300 feet (3,700 m) | ø54" PRCC pipe |
| Total | 19,300 feet (5,800 m) | |

4. Treatment Plant

A. Processes of Treatment

To determine the processes of treatment, it is necessary to obtain data for the quality of raw water. In the stage of planning, however, records of raw water quality of Khanpur source are not available and the following assumptions are made on the water quality:

(a) Since raw water is to be taken from the reservoir at Khanpur Dam, its variation of turbidity will be low compared with the surface water.

(b) A reservoir may frequently permit micro-organisms to grow in it, causing troubles for water treatment. Therefore, pre-treatment of water should be considered.

(c) Since water in Islamabad has high pH values and high alkalinity, it will be necessary to add coagulant in rather large quantities for sedimentation process.

FIG4.6-2 INTAKE PLAN

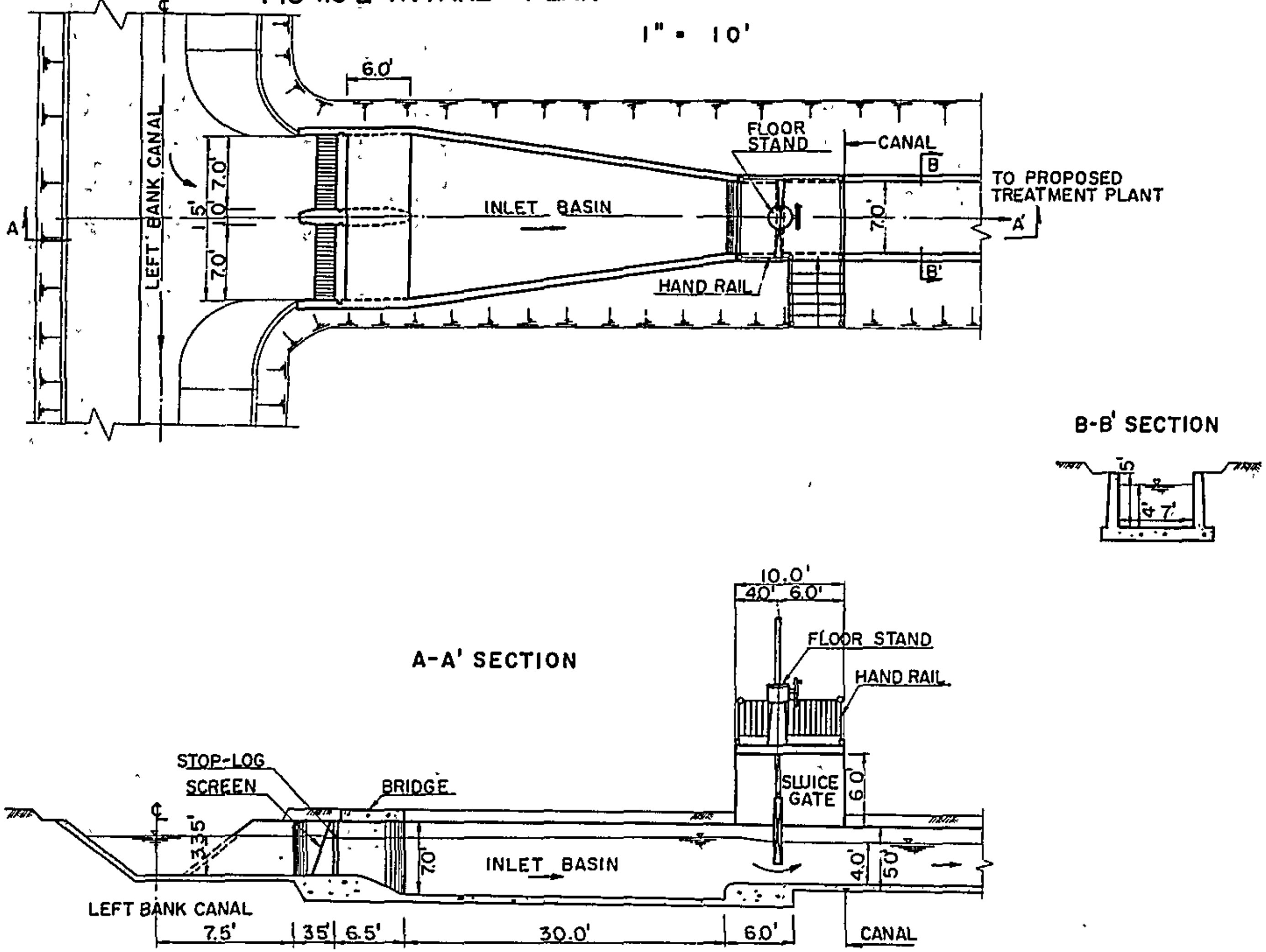
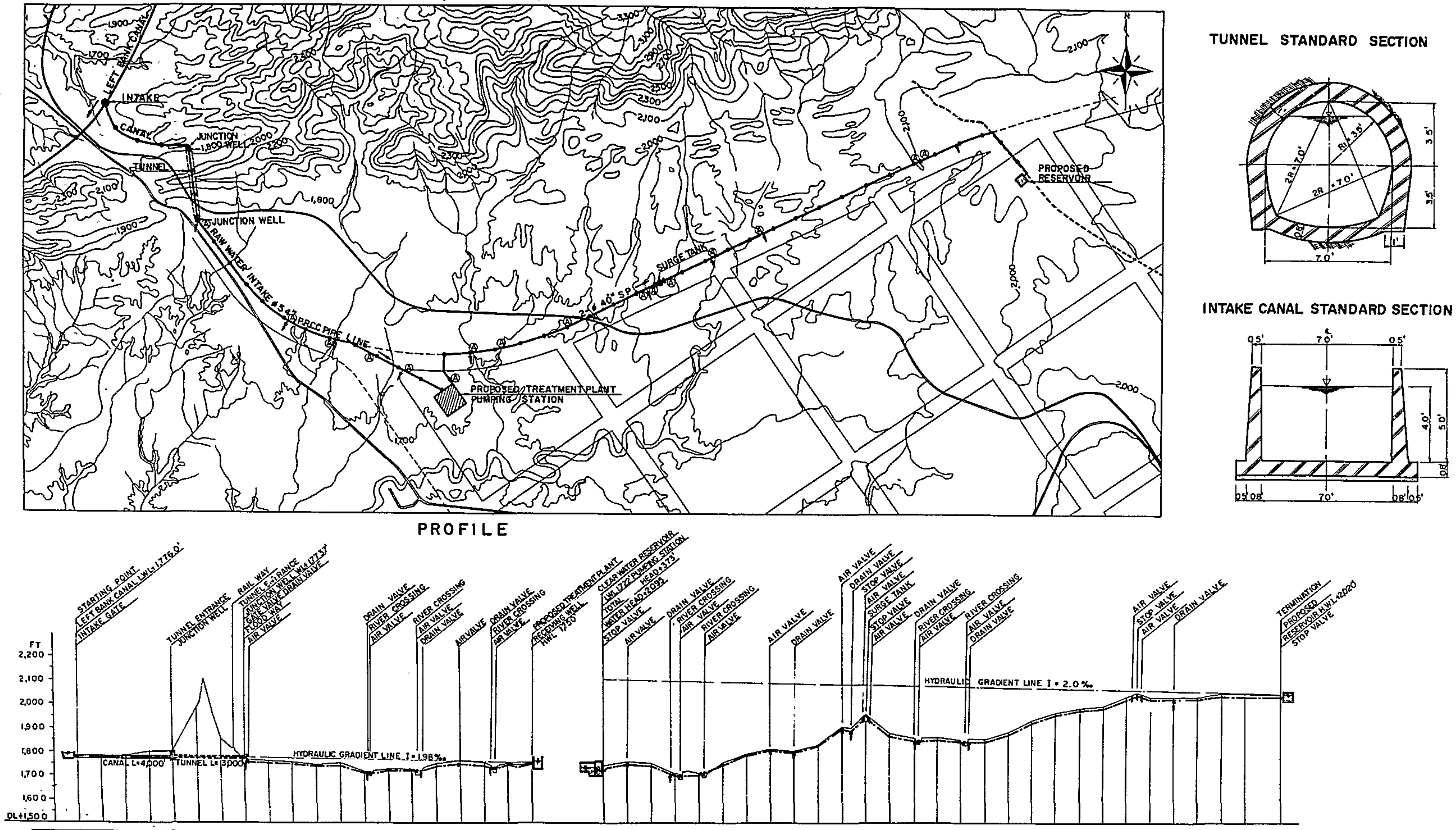


FIG 4.6-3 PLAN - A




| Point | Dist (FT) | T.Dist (FT) | G.H. (FT) | PIPE |
|---|---|---|---|---|
| NO 0 | 0.0 | 0.0 | 1,776.0 | CANAL L=4000' |
| 1 | 1,000.0 | 1,000.0 | 1,776.0 | |
| 2 | 1,000.0 | 2,000.0 | 1,780.0 | |
| 3 | 1,000.0 | 3,000.0 | 1,800.0 | |
| 4 | 1,000.0 | 4,000.0 | 1,800.0 | TUNNEL L=3000 |
| 5 | 1,000.0 | 5,000.0 | 1,980.0 | |
| 6 | 1,000.0 | 6,000.0 | 1,850.0 | |
| 7 | 1,000.0 | 7,000.0 | 1,765.0 | ⌀54" PRCC L=12,300' |
| 8 | 1,000.0 | 8,000.0 | 1,760.0 | |
| 9 | 1,000.0 | 9,000.0 | 1,755.0 | |
| 10 | 1,000.0 | 10,000.0 | 1,745.0 | |
| 11 | 1,000.0 | 11,000.0 | 1,750.0 | |
| 12 | 1,000.0 / 250.0 | 12,000.0 / 12,250.0 | 1,715.0 | |
| 13 | 750.0 | 13,000.0 | 1,725.0 | |
| 14 | 1,000.0 / 200.0 | 14,000.0 / 14,200.0 | 1,725.0 / 1,700.0 | |
| 15 | 800.0 | 15,000.0 | 1,748.0 | |
| 16 | 1,000.0 | 16,000.0 | 1,760.0 | |
| 17 | 1,000.0 / 450.0 | 17,000.0 / 17,450.0 | 1,755.0 | |
| 18 | 550.0 | 18,000.0 | 1,750.0 | |
| 19 | 1,000.0 | 19,000.0 | 1,750.0 | |

| Point | Dist (FT) | T.Dist (FT) | G.H. (FT) | PIPE |
|---|---|---|---|---|
| NO 0 | 0.0 | 0.0 | 1,730.0 | 2-⌀40" SP L=29,500 |
| 1 | 1,000.0 | 1,000.0 | 1,752.0 | |
| 2 | 1,000.0 | 2,000.0 | 1,748.0 | |
| 3 | 1,000.0 / 100.0 | 3,000.0 / 3,100.0 | 1,705.0 | |
| 4 | 900.0 / 300.0 | 4,000.0 / 4,300.0 | 1,710.0 | |
| 5 | 700.0 | 5,000.0 | 1,750.0 | |
| 6 | 1,000.0 | 6,000.0 | 1,770.0 | |
| 7 | 1,000.0 | 7,000.0 | 1,810.0 | |
| 8 | 1,000.0 | 8,000.0 | 1,800.0 | |
| 9 | 1,000.0 | 9,000.0 | 1,825.0 | |
| 10 | 1,000.0 | 10,000.0 | 1,900.0 | |
| 11 | 1,000.0 | 11,000.0 | 1,950.0 | |
| 12 | 1,000.0 | 12,000.0 | 1,888.0 | |
| 13 | 1,000.0 / 200.0 | 13,000.0 / 13,200.0 | 1,855.0 | |
| 14 | 800.0 | 14,000.0 | 1,860.0 | |
| 15 | 1,000.0 / 200.0 | 15,000.0 / 15,200.0 | 1,848.0 | |
| 16 | 800.0 | 16,000.0 | 1,850.0 | |
| 17 | 1,000.0 | 17,000.0 | 1,875.0 | |
| 18 | 1,000.0 | 18,000.0 | 1,925.0 | |
| 19 | 1,000.0 | 19,000.0 | 1,960.0 | |
| 20 | 1,000.0 | 20,000.0 | 1,980.0 | |
| 21 | 1,000.0 | 21,000.0 | 1,990.0 | |
| 22 | 1,000.0 | 22,000.0 | 2,025.0 | |
| 23 | 1,000.0 | 23,000.0 | 2,025.0 | |
| 24 | 1,000.0 | 24,000.0 | 2,025.0 | |
| 25 | 1,000.0 | 25,000.0 | 2,025.0 | |
| 26 | 1,000.0 | 26,000.0 | 2,040.0 | |
| 27 | 1,000.0 | 27,000.0 | 2,040.0 | |
| 28 | 1,000.0 / 500.0 | 28,000.0 / 28,500.0 | 2,040.0 | |

SCALE

FT
0 1,000 2,000 3,000 4,000 5,000
(PLAN)

FT
0 10,000 20,000 30,000
(PROFILE)

(d) It is assumed that other constituents will have nearly the same conditions as the water of rivers in the same area mentioned in paragraph 3.1.4.

From these considerations, it is proposed that the processes to be used at the proposed treatment plant will be sedimentation, filtration and chlorination, plus pre-treatment of chlorine to solve the micro-organism problem referred to in the above (b). Fig. 4.6-4 shows a block diagram of these proposed processes, and the following Figs. 4.6-5, 4.6-6 and 4.6-7 show the proposed treatment plant.

B. Receiving Well

The purpose of the receiving well is to eliminate the residual energy of raw water received and control the water level in the filtration plant. This receiving well will be circular and have a capacity for 45 mgd. Its major dimensions are as follows:

| | |
|---|---|
| Detention time for 45 mgd capacity | 2 minutes |
| Effective volume | 62,000 gallons (278 $m^3$) |
| Diameter of basin | 33 feet |
| Depth of water in basin | 7 feet |

C. Sedimentation Basin

The sedimentation basin proposed consists of a chemical mixing basin, a flocculation basin and a settling basin. These basins are connected and divided into two units for 45 mgd capacity. Accordingly, the design capacity of one unit will be 22.5 mgd (100,000 $m^3$/day).

Chemical mixing will be done by means of jet flow, for which jet pumps will be installed adjacent to the mixing basin. The detention time of the flocculation basin will be 30 minutes. This basin is to be divided into three units, each being equipped with revolving paddles with horizontal shafts for gentle agitation.

The proposed settling basin will be an inclined plates settling basin which originally has been developed in Japan. In the basin, polyvinyl chloride plates are arranged at specified spacings in the settling basin, inclined at an angle of about 60°.

The proposed type of sedimentation basin has a very high efficiency of settling, with the result that the detention time is very short compared with a conventional horizontal flow type settling basin. Moreover, as the inclined plates type basin is similar, in its construction, to the ordinary horizontal flow type, the former can easily be operated and maintained. The detention time designed for this system is about 1.5 hours.

FIG 4.6-4 FLOW CHART SHOWING TREATMENT PROCESSES OF PROPOSED TREATMENT PLANT

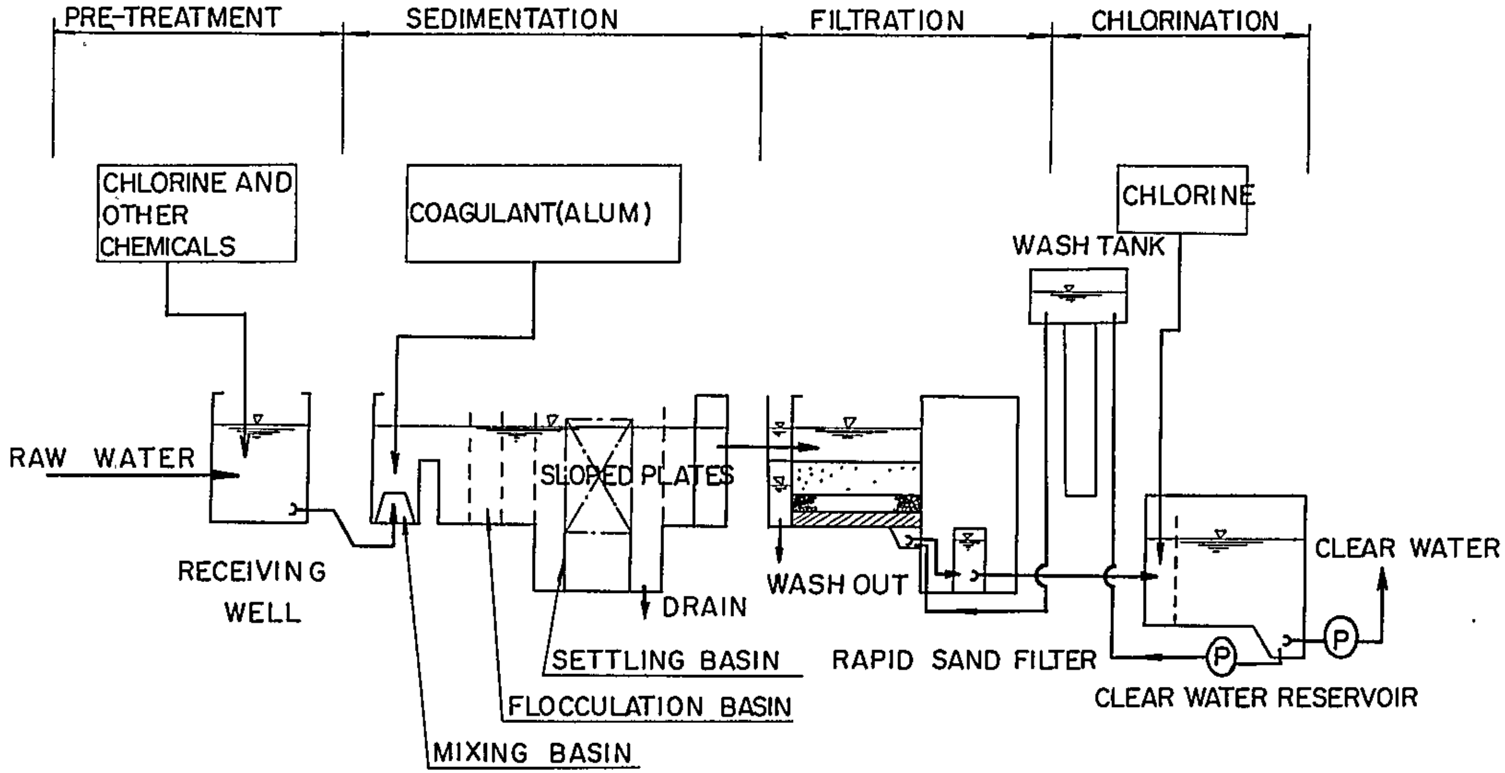
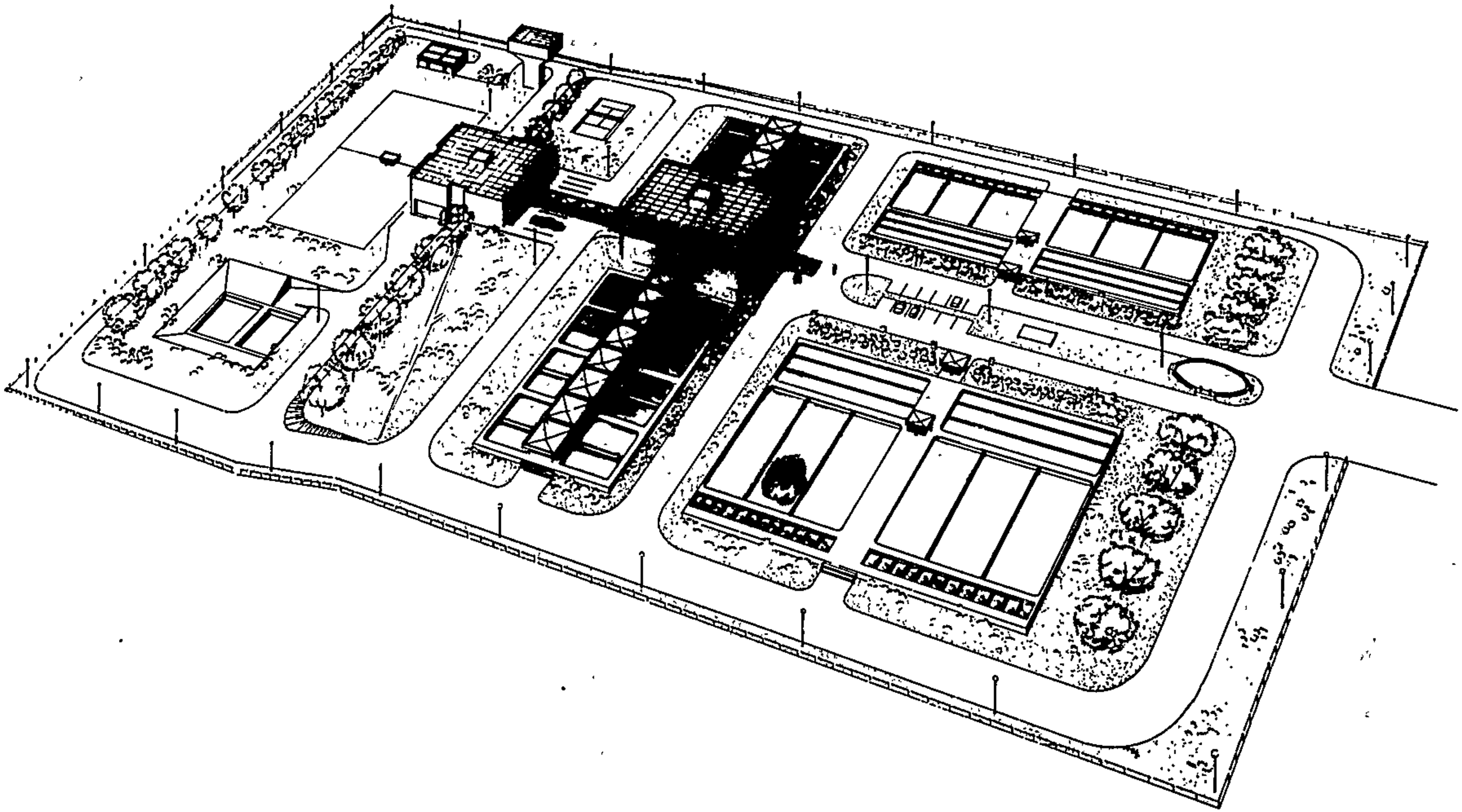


FIG4.6-5 BIRD'S-EYE VIEW OF PROPOSED TREATMENT PLANT



## FIG 4.6-6 PROPOSED TREATMENT PLANT PLAN

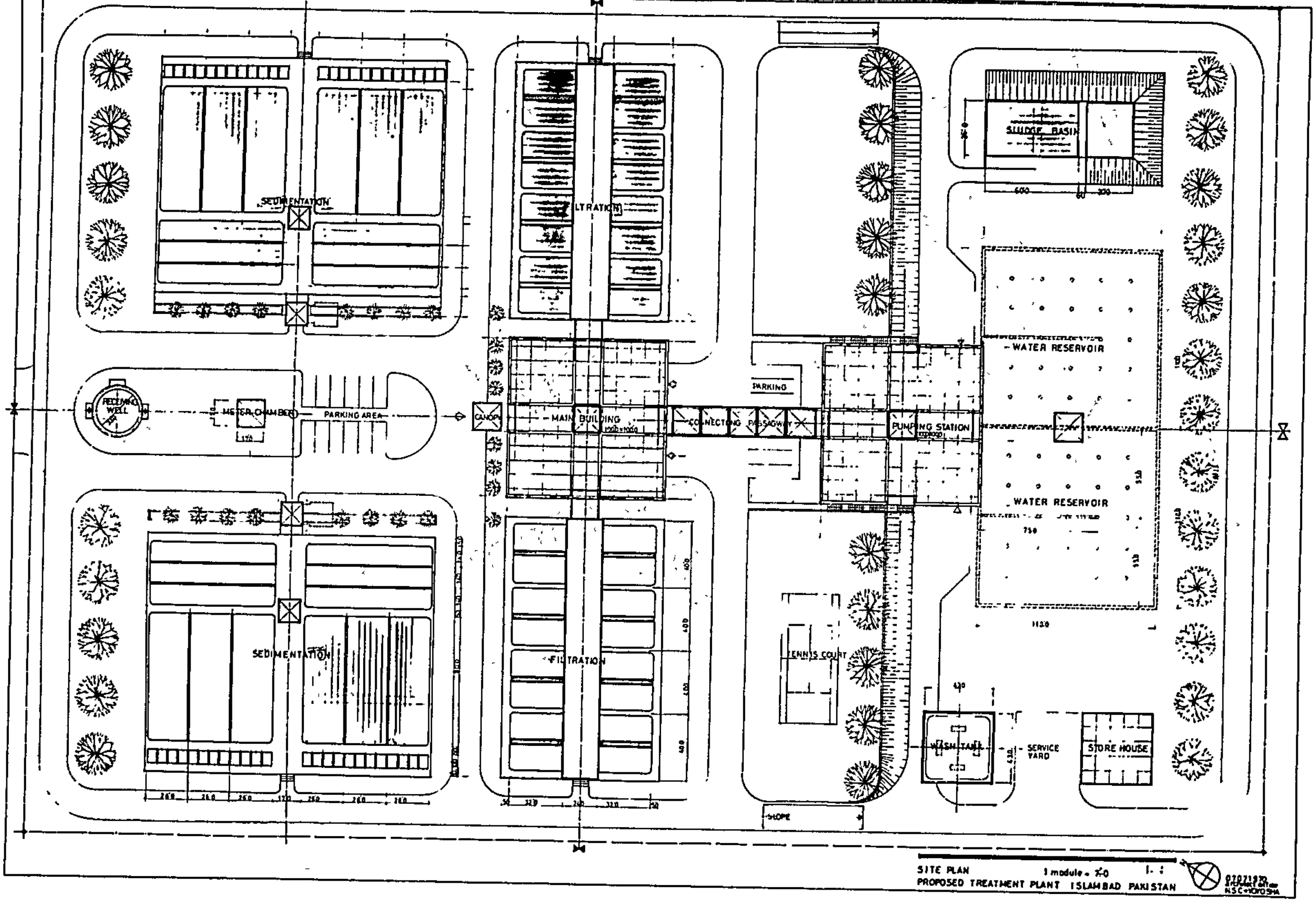
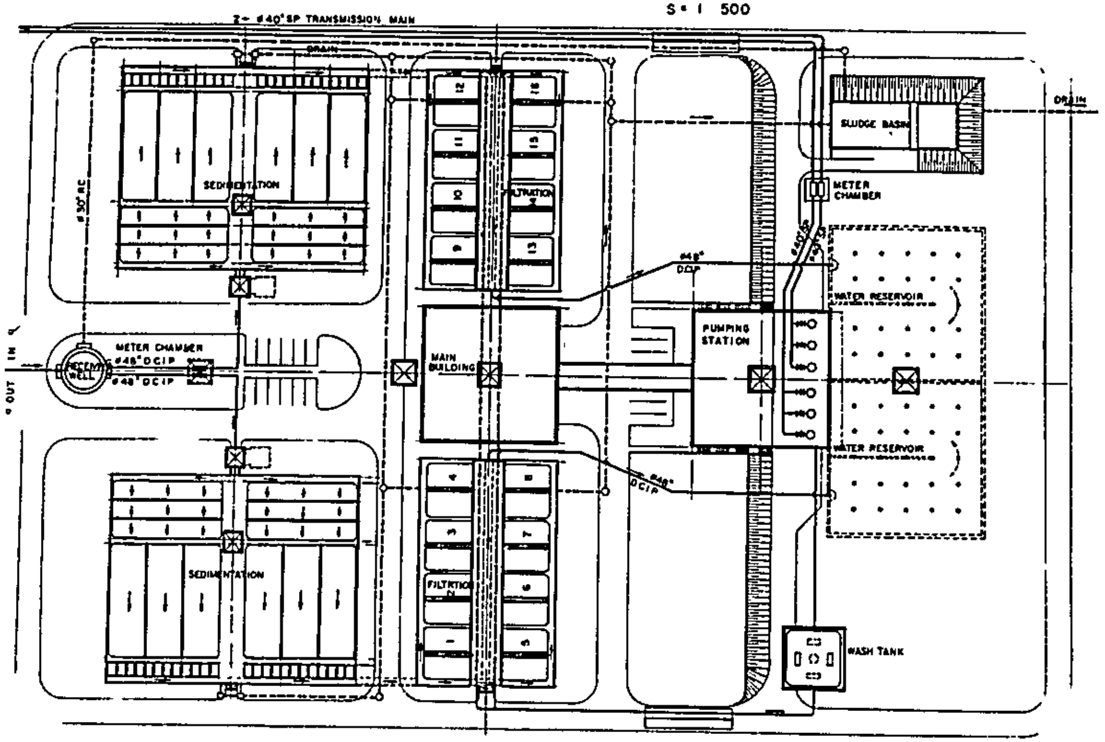


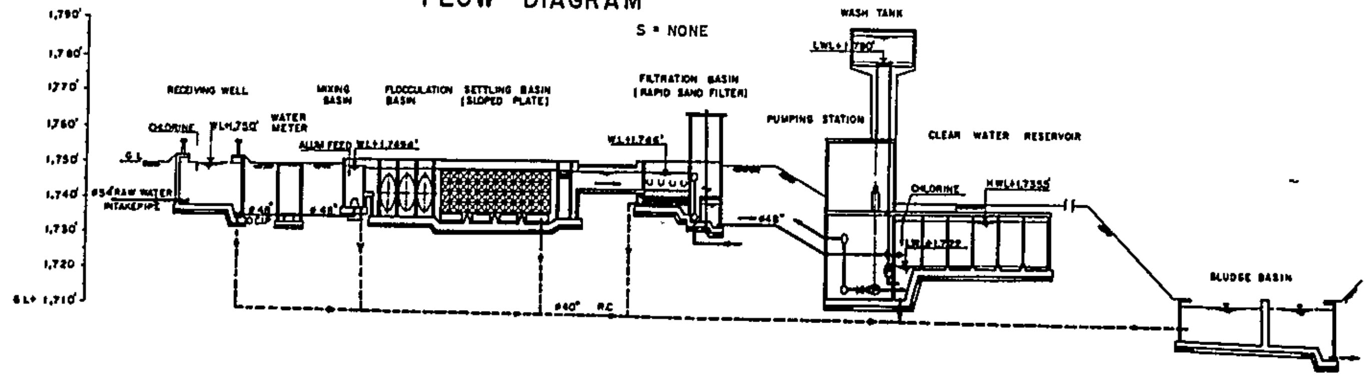
FIG 4.6-7 PROPOSED TREATMENT PLANT

S = 1 500




FLOW DIAGRAM

S = NONE



The proposed settling basin is so constructed that one unit is divided symmetrically at the central boundary in its run-down direction and that motors and other equipments necessary for flocculation, sludge removal, etc. are accommodated in the boundary zone (as a corridor).

Supernatant water after settling will be collected in the troughs located understream of the basin and then introduced through a flume to filtration basins. Dimensions of the mixing, flocculation and settling basins proposed are shown in Table 4.6-3.

Table 4.6-3

Demensions of Sedimentation Basin
(per one unit)

| Item | Ditention time | Effective volume | Depth of water | No. of separated basins |
|---|---|---|---|---|
| Mixing basin | 1 minute | 15.500 gallons ($70\ m^3$) | 11 feet (3.5 m) | 1 |
| Flocculation basin | 30 minutes | 0.46 m.g. ($2.100\ m^3$) | 12 feet (4.0 m) | 2 |
| Settling basin | 1.5 hours | 1.36 m.g. ($6.200\ m^3$) | 12 feet (4.0 m) | 2 |

D. Filtration Unit

Filters used are open gravity type rapid sand filters. The standard filtration rate is fixed to be 120 m/day and a total of 16 basins are installed for the 45 mgd discharge capacity. These basins are divided into two units, each unit consisting of 8 basins. This arrangement has been designed as the result of the two-stage construction program taken into consideration.

Dimensions of one filter basin are as follows:

| | |
|---|---|
| Capacity | 2.8 mgd (12,500 $m^3$/day) |
| Filtration rate | 1.7 gpm/sq.ft. (120 m/day) |
| Filter area | 1,120 sq.ft. (104 $m^2$) |

The filter bed consists of sand layer, filter gravel layer and underdrainage. The bed will be cleaned by back-washing and surface washing. Water for cleaning will be made available by a washing tank and surface washing pumps. Basically, the filtration plant is composed of a pipe gallery located in center with filtration basins at both sides of the gallery. Untreated water from the settling basin runs through the flumes (installed at both sides of the basin) into the filters. Filtered water runs through the treated water conduit installed inside the pipe gallery and then is transmitted to the clear water reservoir through a pipeline. Also arranged in the pipe gallery are pipes for washing and passages for inspection. Above the pipe gallery a control and operation room is provided, where the control equipment is located.

E. Clear Water Reservoir

The purpose of the clear water reservoir is to control the difference between the quantity of treatment and the rate of distribution, to play a role as a suction well and to store water necessary for washing filters. In addition, the reservoir under this project has a function as chlorination chamber. One reservoir will be installed for the 45 mgd capacity with an expected detention time of one hour. Dimensions of the basin are as follows:

| | |
|---|---|
| Detention time for 45 mgd capacity | One hour |
| Effective volume | 1.8 mg (8,400 $m^3$) |
| Depth of water | 12 feet (4 m) |

F. Sludge Disposal

One of the most important unit operations at treatment works is how to dispose sludge drained from sedimentation basins and the filters. Generally, such sludge or wastage is discharged directly into rivers running near the plant or the sludge is half dried into sludge cakes which in turn are dumped to the selected places.

In the former case, water pollution may frequently be caused in the river resulting in trouble with people using the water or living understream of the plant. In the latter case, high costs are required for investment and maintenance of the sludge treatment facilities and moreover there are involved troubles in dumping cakes and selecting the dump place.

With the present development conditions of Islamabad taken into consideration, it is proposed the former method be used for the present stage under the following consideration:

(a) Sludge and wastage from the filter beds will be temporarily deposited in a sludge basin and the supernatant water only will be discharged to rivers.

(b) If it is required to recover wash water in the future, a recovery pump will be installed at the sludge basin to return water to the receiving well.

(c) The sludge basin will have a capacity with some margin over the discharge of one filtration basin.

(d) Sludge from the sedimentation basins will be discharged directly in the river but the rate of discharge will be controlled so that the rivers will be least affected.

G. Operation System and Electric Equipment

Operation of the treatment system will centrally be controlled. Data of water levels, flow discharges, etc. will be systematically indicated or automatically registered in the control center located within the main building. The center will be provided with control panels (or graphic panels) with measuring equipment, thus enabling all the facilities in the plant to be controlled and monitored.

All the equipments driven by power, such as main pumps, mixing pumps, flocculators, chemical feeding pumps, etc. will be remote-controlled manually at the control center. A field control panel will also be provided to permit direct control in the field, in an emergency, if it is required to check in the field. In addition, automatic operation in a limited range is recommendable.

For the time being, it is considered preferable to control the filter plant at the site. The recent tendency is the adoption of automatic operation and control (full automation or remote manual control) for such a filtration plant, but considering function of filters themselves, the field operation and control system will be best suited.

The total power requirement of the proposed filtration plant will be approximately 5,000 KW, 80% of which will be for main pump motors necessary for clear water transmission. In the case of a power capacity exceeding 2,000 KW, the receiving voltage will normally be extra-high tension. Basic arrangement of electric equipment proposed is as follows:

(a) The total contract power capacity for the plant operation will be about 5,000 KW.

(b) The main electric room will be located in the clear water pumping station.

(c) Two power supply sources are desired in order to maintain non-interrupted plant operation.

(d) Basically, all power driven equipment, including main pumps, will be so designed that they can be remote-controlled at the control center in the main building.

(e) An emergency power supply unit will be provided to secure the minimum and necessary power in the event of a power failure. This emergency power supply unit will have a capacity of at least 1,200 KVA to cover one main pump and emergency illumination within the plant.

4. Clear Water Transmission Works

A. Pumping Station

The pumping station will be located in proximity to the clear water reservoir in the premise of the filtration plant. It will consist of the pump room accommodating main pumps and other pumping facilities such as washing water pumps and surface washing pumps, as well as the electric room and emergency power room.

The pumping room will be composed of the ground operation room and the basement located to the same depth as clear water so that main pumps may be conveniently operated. The basement will accommodate pumps and pipes, etc. Installed in the ground operation room are motors for main pumps, operation switches and a travelling crane for use in the event of repairing pumps.

The main pumps provided under the present plan are as follows:

| | |
|---|---|
| Type: | Vertical type centrifugal pumps (double suction system) |
| No. of pumps to be installed: | 6 units (including one spare pump) |
| Unit capacity of pump: | 9 mgd (28 $m^3$/minute) |
| Total head: | 373 feet (115 m) |
| Motor output: | 800 KW |

The reason for vertical type pumps for the present project is; (1) the push-in type suction will permit the starting operation to be easily done and therefore be effective for prevention of cavitation and (2) simplified electric equipments can be used, resulting in economy. Other advantages obtainable by use of vertical type pumps include a reduced floor space required for installation of pumps, and simplified piping arrangements.

B. Transmission Main

The transmission main from the pumping station to the junction well or the reservoir will be two pipelines.

The diameter of the pipeline computed on the basis of discharge necessary for the transmission is 40" (ϕ 1,200 mm) per line, while total length of the proposed pipeline is 29,500 feet (8,950 m), as shown in Fig. 4.6-3.

As to the type of pipe, it is desirable to use a steel pipe because it should feed water under high pressure. The most important problem to be considered in a pipeline through which water is fed by pump, is the generation of water hammering arising from a sudden stop of pumps in the event of power supply interruption. Such incident also has an important relation with the profile of the pipeline. The pipeline under the present project is not always considered to be favorable for requirements involved, as can be understood from Fig. 4.6-3. Therefore, it may be necessary to provide such safety devices as a surging tank for prevention of breakdown of the pipeline which may be caused by abnormal negative pressure in the pipe due to water hammering.

4.6.3 Distribution Pipes

For the increased population after the year of 1981, the proposed Khanpur Filtration Plant will supply water to all the service area divided to three parts of high, middle and low area.

The population in the low service area of the proposed Khanpur water supply system is 177,500 in 2000. Therefore, the reservoir for the low service area should have enough capacity for the demand of 17.75 mgd for the maximum day consumption of 177,500 persons.

The diameter of connection pipe to the reservoir for the low service area is designed for 17.75 mgd.

The capacity of the reservoir for low service area is 4.5 mg as six hours storage of maximum day demand in 2000.

The population in the middle service area of Khanpur water supply system in 2000 is 271,000, and the capacity of the reservoir for the area is 9 mg as storage of six hours for maximum day demand in 2000.

The population in the high service area in 2000 is only 21,000. Therefore the capacity of reservoir for the high service area is 0.7 mg.

The results of rough calculation of the distribution main grids in each service area are shown in the Fig. 4.6-8

The diameter and length of distribution mains as 2nd stage works are as follows:

| Diameter in inches | Length in feet |
|---|---|
| 40" | 15,000 |
| 36" | 62,000 |
| 24" | 77,000 |
| 18" | 65,000 |
| 12" | 62,000 |
| 10" | 46,000 |
| 8" | 180,000 |
| Total | 507,000 |

The total length of distribution pipes with diameter of 3 inches upto 10 inches in above service area is estimated at 220,000 feet based on examples of Japanese cities with similar population.

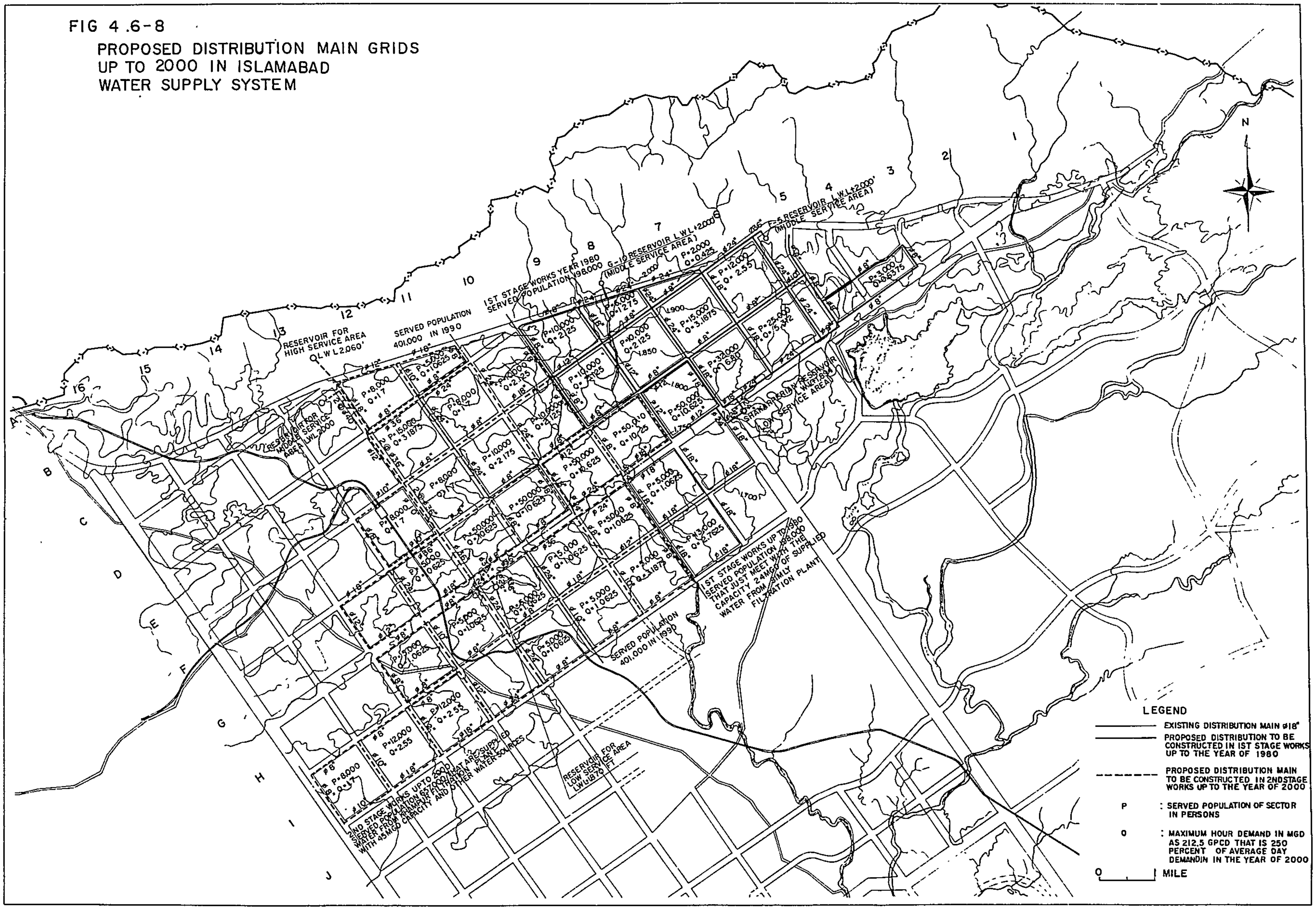
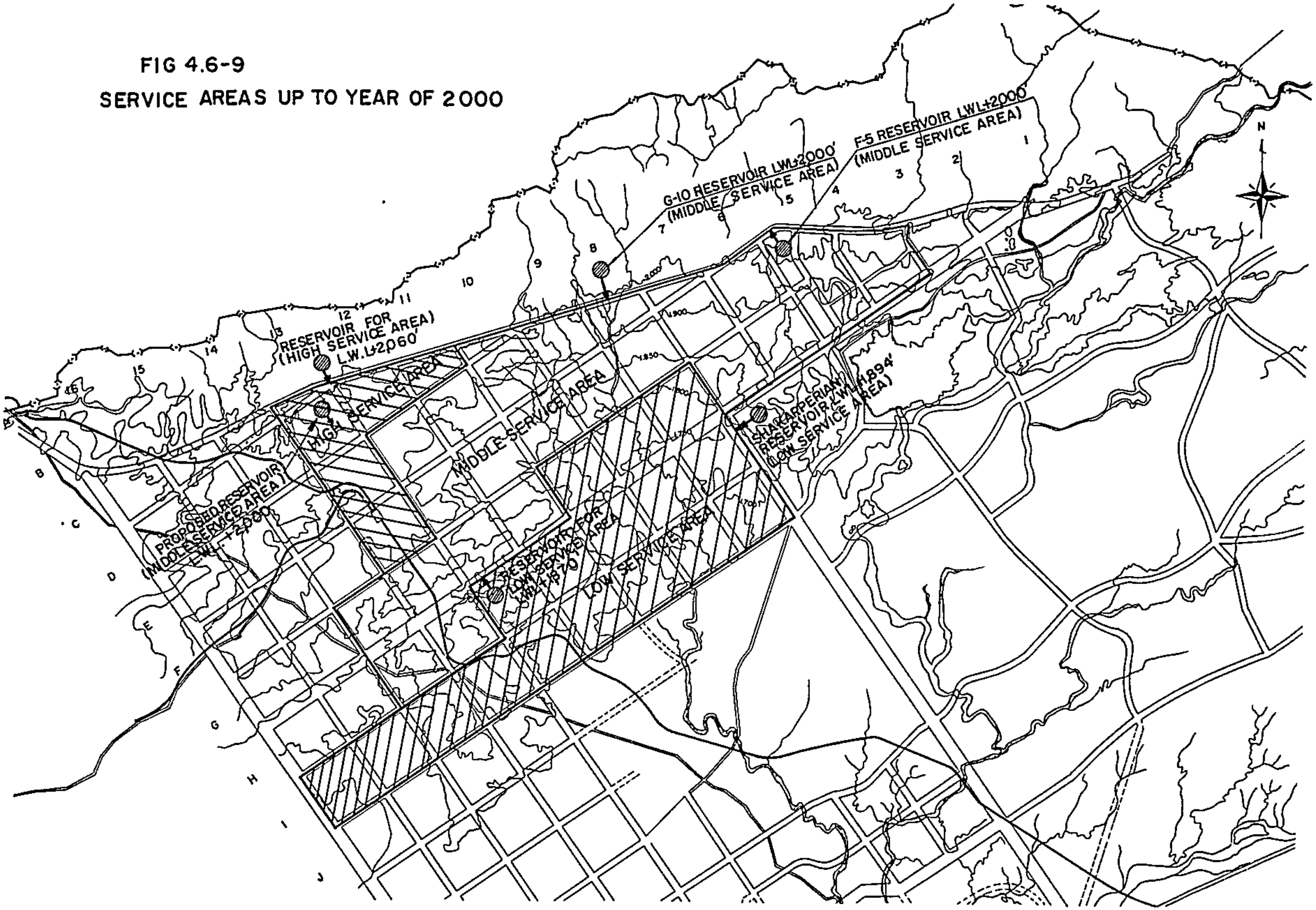



FIG 4.6-8
PROPOSED DISTRIBUTION MAIN GRIDS UP TO 2000 IN ISLAMABAD WATER SUPPLY SYSTEM

FIG 4.6-9

SERVICE AREAS UP TO YEAR OF 2000



# CHAPTER 5

# COST ESTIMATE

5.1 Basic Assumptions

5.2 Summary of Estimated Construction Cost

# CHAPTER 5

# COST ESTIMATE

## 5.1 Basic Assumption

In estimating construction costs, the natural regional conditions of the project site, the scale of the works and the technological standards which are required are taken into consideration and calculations made based on the commodity prices as of March, 1970.

1) Scope of Construction Cost Estimates

The scope of construction cost estimates covers the items of works as follows:

Rehabilitation Works in 1970.

(a) Existing Simly conduction main
Leakage repairs
Replacing the existing pipe of 100 feet at Gumreh Kas

(b) Existing distribution pipes
Leakage repairs and replacing of valves.

(c) Water meter repair parts

Improvement of existing water meter of 40,000 numbers.

(d) Miscellaneous

Venturi meters ø18"
Chemical feeders
Chlorinators
Automatic gate for diversion tunnel at Simly Dam.

1st stage works from 1971 to 1980

(a) Up-stream coffer dam of Simly Dam

(b) Diversion tunnel of Simly Dam

(c) Construction of Simly Dam

(d) Small check dams

(e) Extention of Simly Conduction Main

| | |
|---|---|
| Diameter of pipe | 36" (900 mm) |
| Total length of pipes | 91,000 feet (27,300m) |

(f) Laying of distribution pipes

Distribution Mains

ø8" - ø36"    188,000 feet

Distribution pipe

ø3" - ø10"    150,000 feet

2nd Stage Works from 1981 to 2000

(a) Construction of proposed Khampur Filteration plant including intake, raw water transmission main, treatment plant, clear water transmission main.

(b) Laying of distribution pipe

Distribution mains

ø8" - ø40"    507,000 feet

Distribution pipes

ø3" - ø10"    220,000 feet

2) Construction Costs of Civil Engineering Works

(a) Work quantities were estimated from the preliminary design drawings of this Report.

(b) Regarding basic prices, the expenses for materials to be procured in Pakistan and for labor are based on the price on March, 1970. The price of imported construction machinery, equipment and materials are also based on March, 1970 price.

(c) Construction costs are calculated on performance in Pakistan, and the information obtained from experience with similar works in Japan. The unit cost of major works for 1st stage works such as excavation of dam foundation, dam embankment are estimated by daily quantity methods. In other words, the type of construction machinery, equipment and periods of use are determined first according to the construction schedule and work quantities. Next, based on the results, the necessary labor, material and equipment cost are calculated to obtain the direct construction cost.

(d) Customs duties on imported materials and imported construction machinery and equipment are all excluded in the construction cost.

(e) A contingency reserve of 15% is included for the construction cost of civil engineering works.

3) Cost of Equipment, Machinery and Materials

(a) Equipment and machinery such as bulldozers, power shovels, wheel loaders, dump trucks, etc., for civil engineering works and materials such as electric detonator, exploder, steel supports and pipes are all assumed to be Japanese manufacture and furnished from Japan.

(b) The costs of various equipment, machinery and materials are calculated by adding ocean freight, insurance, landing costs, overland transportation costs in Pakistan to the FOB price in Japan.

(c) A contingency reserve of 5% of the cost of equipment, machinery and materials is included.

4) Engineering Fees

5% of the construction cost are included as engineering fees for detailed designing and supervision.

5) Administrative Cost

The field allowance of CDA personnel dispatched to the project and the expenses of offices, living quarters and automobiles required by CDA and the Consulting Engineers and of other necessary facilities are included as administrative cost at 4% of construction cost.

6) Land Acquisition Costs

The cost of land acquisition for all works and also the compensation for this is excluded in the estimate.

7) Interest during Construction

Interest during construction is calculated based on annual construction fund requirements.

8) Local and Foreign Currency

Construction costs are divided into local and foreign currency payments.

Wages of indigenous labor, on-site living expenses of foreign labor and engineers, cost of materials procured in Pakistan are included under local currency. Other expenses are included under foreign currency. Exchange rates are calculated to be the official rates of U.S.$1.00 = Pak. Rs.4.76 = ¥360.

## 5.2 Summary of Construction Cost

5.2-1 The summary of construction cost is given in Table 5.2-1. The components of foreign currency out of total construction costs on 1st stage works are shown in Table 5.2-2; and also the components of local currency out of total construction costs on 1st stage works is shown in Table 5.2-3. The construction cost of 2nd stage works based on the construction schedule is indicated in Table 5.2-4. Construction costs of distribution pipes are estimated based on the unit price shown in Table 5.2-5. Construction cost befor 1970 in the first column is shown minutely in Table 5.2-6.

Table 5.2-7 and Table 5.2-8 show in detail respectively the machinery equipments and materials imported from Japan for the construction of Simly Dam.

Table 5.2-1

Summary of Estimated Construction Cost

Unit: US$

| | Total cost | Foreign currency | Local currency |
|---|---|---|---|
| 1. Rehabilitation Works | | | |
| 1-1, Simly Conduction Main-1 | 61,000 | 55,000 | 6,000 |
| 1-2, Pipe Joint and Valves | 34,000 | 31,000 | 3,000 |
| 1-3, Water Meter | 132,000 | 120,000 | 12,000 |
| 1-4, Venturi Meter | 110,000 | 100,000 | 10,000 |
| 1-5, Chemical Feeders | 66,000 | 60,000 | 6,000 |
| 1-6, Chlorinators | 66,000 | 60,000 | 6,000 |
| 1-7, Automatic Gate for Diversion Tunnel | 33,000 | 30,000 | 3,000 |
| Sub-total-1 | 502,000 | 456,000 | 46,000 |
| 2. 1st Stage Works | | | |
| 2-1, Up-Stream Coffer Dam of Simly Dam | 240,000 | - | 240,000 |
| 2-2, Diversion Tunnel of Simly Dam | 1,950,000 | - | 1,950,000 |
| 2-3, Simly Dam | 21,109,000 | 11,204,000 | 9,905,000 |
| 2-4, Small Cheak Dam | 200,000 | - | 200,000 |
| 2-5, Simly Conduction Main-2 | 3,194,000 | 2,742,000 | 452,000 |
| 2-6, Distribution Pipes | 2,514,000 | 2,191,000 | 323,000 |
| 2-7, Engineering Fee (5%) | 1,460,000 | 1,168,000 | 292,000 |
| 2-8, Administration Cost (4%) | 1,168,000 | - | 1,168,000 |
| Escalation 4% per annum | 3,778,000 | 2,087,000 | 1,691,000 |
| Sub-total-2 | 35,613,000 | 19,392,000 | 16,221,000 |
| 3. 2nd Stage Works | | | |
| 3-1, Khampur Filtration Plant | 14,333,000 | 6,656,000 | 7,677,000 |
| 3-2, Reservoirs | 3,611,000 | - | 3,611,000 |
| 3-3, Distribution Pipes | 6,995,000 | 6,202,000 | 793,000 |
| 3-4, Engineering Fee (5%) | 1,250,000 | 1,000,000 | 250,000 |
| 3-5, Administration Costs (4%) | 998,000 | - | 998,000 |
| Escalation 4% per annum | 21,087,000 | 10,748,000 | 10,339,000 |
| Sub-total-3 | 48,274,000 | 24,606,000 | 23,668,000 |
| Total | 84,389,000 | 44,454,000 | 39,935,000 |

Table 5.2-2

Component of Foreign Currency Out of Total Construction Costs of 1st Stage Works Upto 1980

Unit: US$1,000

| | | Foreign Currency | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. | 1st Stage Works | | | | | | | | | | | |
| 2-1 | Up-Stream Coffer Dam | - | | | | | | | | | | |
| 2-2 | Diversion Tunnel | - | | | | | | | | | | |
| 2-3 | Simly Dam | 11,204 | 204 | 5,000 | 5,000 | 1,000 | | | | | | |
| 2-4 | Simly Conduction Main - II | 2,742 | 1,300 | 1,300 | 142 | | | | | | | |
| 2-5 | Distribution Pipe | 2,191 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 220 | 211 |
| 2-6 | Engineering Fee (5%) | 1,168 | 40 | 330 | 330 | 250 | 218 | | | | | |
| 2-7 | Administration Cost (4%) | - | - | - | - | - | | | | | | |
| | Total - 2 | 17,305 | 1,764 | 6,850 | 5,692 | 1,470 | 438 | 220 | 220 | 220 | 220 | 211 |
| Escalation 4% per Annum | | 2,087 | 71 | 559 | 710 | 250 | 95 | 58 | 69 | 81 | 93 | 101 |
| Grand Total | | 19,392 | 1,835 | 7,409 | 6,402 | 1,720 | 533 | 278 | 289 | 301 | 313 | 312 |

Table 5.2-3

Component of Local Currency Out of Total Construction Costs of 1st Stage Works Upto 1980

Unit: US$1,000

| | Local Currency | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. 1st Stage Works | | | | | | | | | | | |
| 2-1 Up-Stream Coffer Dam | 240 | 240 | | | | | | | | | |
| 2-2 Divension Tunnel | 1,950 | 1,950 | | | | | | | | | |
| 2-3 Simly Dam | 9,905 | 124 | 3,400 | 4,200 | 2,181 | | | | | | |
| 2-4 Small Check Dam | 200 | 200 | | 52 | | | | | | | |
| 2-5 Simly Conduction Main - II | 452 | 200 | 200 | 52 | | | | | | | |
| 2-6 Distribution Pipes | 323 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 53 |
| 2-7 Engineering Fee (5%) | 292 | 20 | 70 | 70 | 70 | 62 | | | | | |
| 2-8 Administration Cost (4%) | 1,168 | 10 | 200 | 200 | 150 | 150 | 150 | 80 | 80 | 80 | 68 |
| Total | 14,530 | 2,774 | 3,900 | 4,552 | 2,431 | 242 | 180 | 110 | 110 | 110 | 121 |
| Escalation (4% per Annum) | 1,691 | 111 | 318 | 568 | 413 | 52 | 48 | 35 | 41 | 47 | 58 |
| Grand Total | 16,221 | 2,885 | 4,218 | 5,120 | 2,884 | 294 | 228 | 145 | 151 | 157 | 179 |

Table 5.2-4

Construction Cost of 2nd Stage Works Upto 2000

Unit: US$1,000

| | Total cost | 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|
| 3. 2nd Stage Works | | | | | | |
| 3-1 Khampur Filteration Plant | 14,333 | 5,000 | 5,000 | 4,333 | | |
| 3-2 Reservoirs | 3,611 | 1,000 | 1,000 | 1,000 | 611 | |
| 3-3 Distribution Pipes | 6,995 | 2,000 | 2,000 | 2,000 | 600 | 395 |
| 3-4 Engineering Fee (4%) | 1,250 | 750 | 250 | 250 | | |
| 3-5 Administration Cost (5%) | 998 | 200 | 200 | 200 | 200 | 198 |
| Total - 3 | 27,187 | 8,950 | 8,450 | 7,783 | 1,411 | 593 |
| Escalation 4% per Annum | 21,087 | 4,298 | 5,611 | 7,946 | 2,054 | 1,178 |
| Grand Total | 48,274 | 13,248 | 14,061 | 15,729 | 3,465 | 1,771 |

Table 5.2-5

Price of Distribution Pipe and Cost of Pipe Laying

| Dia. in Inches | Price of Pipes | | Cost of Pipe Laying |
|---|---|---|---|
| | US$/foot | Rs/foot | Rs/foot |
| ϕ40" | 36.9 | 175.6 | 13.0 |
| ϕ36" | 29.7 | 141.4 | 12.0 |
| ϕ24" | 15.1 | 71.9 | 9.0 |
| ϕ18" | 9.7 | 46.2 | 6.0 |
| ϕ12" | 5.8 | 27.6 | 4.5 |
| ϕ10" | 5.1 | 24.3 | 4.0 |
| ϕ 8" | 4.1 | 19.5 | 3.5 |
| ϕ 6" | 3.1 | 14.8 | 3.0 |

Note: Including metal road cutting and valve box.

Table 5.2-6

Construction Costs for the Existing Water Works

| | | | |
|---|---|---|---|
| Data by CDA | | | |
| 1. | Simly Filtration Plant | Rs. 21,181,058 | = US$4,450,000 |
| 2. | Simly Conduction Main | Rs. 3,023,073 | = US$ 635,000 |
| 3. | G-10 Head Works | Rs. 3,279,000 | = US$ 689,000 |
| 4. | Golf Course Head Works | Rs. 2,060,000 | = US$ 433,000 |
| 6. | Reservoirs in Islamabad (2 places) | Rs. 5,590,000 | = US$1,174,000 |
| | Sub-total | | US$7,381,000 |
| Presumed Value by Japan Survey Team | | | |
| 7. | Saidpur Head Works | Rs. 1,500,000 | = US$ 315,000 |
| 8. | Nurpur Head Works | Rs. 1,500,000 | = US$ 315,000 |
| 9. | Existing Golf Course Head Workd | Rs. 2,000,000 | = US$ 420,000 |
| 10. | Korang Head Works | Rs. 1,500,000 | = US$ 315,000 |
| 11. | Shahdra Head Works | Rs. 1,500,000 | = US$ 315,000 |
| 12. | Tube Wells (10 numbers) | | US$ 100,000 |
| 13. | Distribution Pipe 210,000 feet @ US$4 | | US$ 810,000 |
| | Sub-total | | US$2,590,000 |
| | Total | | US$9,971,000 |

Table 5.2-7

Required Construction Machinery and Equipment from Japan for Simly Dam

| Item | Description | Numbers |
|---|---|---|
| Bulldozer | D-80 | 8 |
| " | D-120 | 21 |
| Power shovel | 2 $m^3$ | 4 |
| Wheel loader | 2.3 $m^3$ | 5 |
| " | 5 $m^3$ | 4 |
| Tractor shovel | D-60s | 3 |
| Dump truck | HD-35 | 38 |
| Dump truck | HD-15 | 25 |
| Truck clane | 32 ton | 2 |
| Dump truck | 8 ton | 4 |
| Hydraulic clane | 7 ton | 3 |
| Motor grader | 11.5 ton | 2 |
| Tore roller | 20 ton | 2 |
| Sheeps foot roller | 3.5 ton | 3 |
| Vibration roller | | 2 |
| Tamper | 120 kg | 10 |
| Rammer | 80 kg | 10 |
| Air rammer | F 4 | 20 |
| Compressor | AMR 200 | 3 |
| " | AM 600 | 8 |
| Crawler drill | CD-3 | 15 |
| Leg drill | TY24LD | 20 |
| Coal pick hummer | | 20 |
| Rocker shovel | DS-5 | 2 |
| Dump truck | 2 ton | 4 |
| Ordinary truck | 8 ton | 6 |
| Tractor and trailer | 30 ton | 1 |
| Water tanker | 6 $m^3$ | 2 |
| Fuel tanker | 7 $m^3$ | 2 |
| Grease car | | 1 |
| Batcher plant | 1.5 $m^3$ x 2 | 1 |

| | | |
|---|---|---|
| Crushing plant | 150 ton/hr | 1 |
| Agitator truck | 3 $m^3$ | 12 |
| Concrete mixer | 0.5 $m^3$ | 2 |
| Portable belt conveyor | | 10 |
| Concrete vibrator | | 20 |
| Asphalt distributor | | 2 |
| Winch | 11, 22, 37 | 6 |
| Concrete bucket | 1.5 $m^3$ | 4 |
| Boring machine | | 6 |
| Grout pump | | 6 |
| Water pump | 2.7 $m^3$<br>100 KW | 3 |
| " | 200 mm Submergable | 4 |
| " | 150 mm " | 4 |
| " | 100 mm " | 4 |
| Blower | 600 mm | 4 |
| Jeep | | 8 |
| Sedan | | 3 |
| Bus | | 2 |
| Fork lift | | 2 |
| Ordinary truck | 8 ton | 4 |
| Saw mill | | 1 |
| Bar bender | | 1 |
| H steel bender | | 1 |
| Tire tube shop | | 1 |
| Repair shop | | 1 |

Table 5.2-8

Construction Material from Japan for Simly Dam

| | | | |
|---|---|---|---|
| 1. | Explosive | | 1,120 ton |
| | Electric detonator | | 6,000,000 nos |
| | Leg wire | | 18,000 km |
| | Exploder | | 5 nos |
| | Tester | | 5 nos |
| 2. | Steel Material | | |
| | Steel support | | 350 ton |
| | Shaped steel | | 80 ton |
| | Steel form | | 300 ton |
| | Pipe support | | 100 ton |
| | Reinforced steel | | 550 ton |
| | Pipe | | 410 ton |
| 3. | Rod & Bit | | |
| | Rod | 22ϕ | 4,400 m |
| | " | 38ϕ | 4,700 m |
| | Bit | 38ϕ | 2,200 nos |
| | " | 38ϕ | 3,900 nos |

# CHAPTER 6

# ECONOMIC CONSIDERATION

# CHAPTER 6

# ECONOMIC CONSIDERATION

In this chapter forecasts of revenue and expenditure of the proposed water supply project will be treated.

First consideration to be given is revenue. Revenue depends upon mainly two factors; amount of water sales and rate of water sales vary with progress of rehabilitation and extention works, but in this report water sales by year are calculated based on the assumptions that have been treated in previous chapters.

Regarding water sales, which is the most important factor to affect the water supply business a provisional rate is adopted. This provisional rate has tentatively been calculated so as to balance the total expected revenue in the coming 16 years to expenditure of the same period. Possibility of enforcing this rate must be further studied.

Second consideration to be given to economics of the proposed water supply project is expenditure. Operating costs such as power, chemical, salaries and others are calculated as shown in following tables. The most important, but not exactly determinate factors are non-operating costs. It is because the sources of construction funds are not determined yet. Interest rate, grace period and amortization period, which are all to determine yearly cash expenditure as well as non-operating costs, are not fixed yet, and they must be assumed at a certain level.

In this report, these factors are assumed as described in following sections and tables.

## 6.1 Water Sales

Served population and per capita consumption were thoroughly and in details discussed in Chapter 4. From this, water sales are estimated, including unaccounted-for water. The amount of unaccounted-for water must be gradually reduced in order to maintain the water supply on a sound basis.

Hence this proposal includes preparation of a program to rehabiliate the existing systems and to reduce the amount of unaccounted-for water.

Unaccounted-for water is percentage of leakage and wastage by year and water for fire service, religious and charitable institutions.

Served population and water sales by year are estimated as shown in Table 6.1-1.

Table 6.1-1

Annual Water Sales

| Years | Served population | Accounted Water | | |
|---|---|---|---|---|
| | | gpcd | gd | Thousand gallons per year |
| 1970 | 75,000 | 50 | 3,750,000 | 1,368,750 |
| 1971 | 90,000 | 50.66 | 4,559,400 | 1,664,181 |
| 1972 | 105,000 | 51.32 | 5,388,600 | 1,966,839 |
| 1973 | 120,000 | 51.98 | 6,237,600 | 2,226,724 |
| 1974 | 135,000 | 52.64 | 7,106,400 | 2,593,836 |
| 1975 | 150,000 | 53.4 | 7,995,000 | 2,918,175 |
| 1976 | 165,000 | 54.0 | 8,910,000 | 3,252,150 |
| 1977 | 180,000 | 54.7 | 9,846,000 | 3,593,790 |
| 1978 | 195,000 | 55.4 | 10,803,000 | 3,943,095 |
| 1979 | 210,000 | 56.1 | 11,781,000 | 4,300,065 |
| 1980 | 225,000 | 56.8 | 12,780,000 | 4,664,700 |
| 1981 | 260,000 | 57.41 | 14,926,600 | 5,448,209 |
| 1982 | 295,000 | 58.02 | 17,115,900 | 6,247,304 |
| 1983 | 330,000 | 58.63 | 18,753,900 | 6,845,174 |
| 1984 | 365,000 | 59.32 | 21,655,450 | 7,904,239 |
| 1985 | 400,000 | 60.5 | 24,200,000 | 8,833,000 |
| Total | | | | 67,820,231 |

## 6.2 Operation and Maintenance Cost

Annual costs of operation and maintenance which includs escalation 4% per annum are shown in Table 6.2-1, Table 6.2-2 and Table 6.2-3.

Escalation rate of goods price 4% was tentatively adopted in this report. The recent trend of escalation is about 4% annum, but it is questionable to use this figure all over the future years.

It must be reviewed and revised in the course of the project.

Table 6.2-1

Personnel, Miscellaneous & Repair Expenditure

| Years | Personnel expenditure | | Miscel-laneous | Repair expenses | Remarks |
|---|---|---|---|---|---|
| | Numbers of worker | Annual expendi-ture | | | |
| | US$ | US$ | US$ | US$ | |
| 1970 | 2,400/year @ 20 | 48,000 | 9,600 | 4,800 | Personnel expenditure: US$200 per capita per month |
| 1971 | 2,500 @ " | 50,000 | 10,000 | 5,000 | Miscellaneous expenses = personnel expenditure x 20% |
| 1972 | 2,600 @ " | 52,000 | 10,400 | 5,200 | Repair expenses = personnel expenditure x 10% |
| 1973 | 2,700 @ " | 67,500 | 13,500 | 6,750 | Including escalation 4% annum |
| 1974 | 2,800 @ " | 70,000 | 14,000 | 7,000 | |
| 1975 | 2,900 @ 30 | 87,000 | 17,400 | 8,700 | |
| 1976 | 3,040 @ " | 91,200 | 18,240 | 9,120 | |
| 1977 | 3,160 @ " | 94,800 | 18,960 | 9,480 | |
| 1978 | 3,280 @ 35 | 114,800 | 22,960 | 11,480 | |
| 1979 | 3,400 @ " | 119,000 | 23,800 | 11,900 | |
| 1980 | 3,550 @ 40 | 142,000 | 28,400 | 14,200 | |
| 1981 | 3,700 @ " | 148,000 | 29,600 | 14,800 | |
| 1982 | 3,840 @ " | 153,600 | 30,720 | 15,360 | |
| 1983 | 4,000 @ " | 160,000 | 32,000 | 16,000 | |
| 1984 | 4,160 @ " | 166,400 | 33,280 | 16,640 | |
| 1985 | 4,320 @ " | 172,800 | 34,560 | 17,280 | |
| TOTAL | | 1,737,100 | 347,420 | 173,710 | |

Table 6.2-2

Cost of Chemicals for Water Supply

| Years | Total supplied water in gallons per annum | Unit price of chemicals US$ per gallon | Total cost in US$ | Remarks |
|---|---|---|---|---|
| 1970 | 2,737,500 | 0.006 | 1,807 | Dosage rate of chlorine US$0.0066/gallon |
| 1971 | 3,263,100 | 0.0069 | 2,252 | Unit price of chlorine Rs.1,568/ton = US$330/ton |
| 1972 | 3,782,383 | 0.0071 | 2,685 | Including escalation 4% per annum |
| 1973 | 4,295,706 | 0.0074 | 3,179 | |
| 1974 | 4,803,400 | 0.0077 | 3,699 | |
| 1975 | 5,211,000 | 0.0080 | 4,169 | |
| 1976 | 5,705,526 | 0.0084 | 4,793 | |
| 1977 | 6,196,189 | 0.0088 | 5,453 | |
| 1978 | 6,683,211 | 0.0091 | 6,082 | |
| 1979 | 7,049,286 | 0.0095 | 6,697 | |
| 1980 | 7,404,285 | 0.0099 | 7,330 | First stage works are completed |
| 1981 | 8,512,826 | 0.0108 | 8,768 | |
| 1982 | 4,611,236 | 0.0107 | 10,284 | |
| 1983 | 10,371,475 | 0.0111 | 11,512 | |
| 1984 | 11,976,119 | 0.0117 | 13,773 | |
| 1985 | 13,183,582 | 0.0120 | 15,820 | |
| Total | | | 108,303 | |

Table 6.2-3

Cost of Electricity

Unit: US$

| Years | Annual consumption of electricity | Unit charge of electricity per KWH including escalation 4% annum | Annual expenditure | Remarks |
|---|---|---|---|---|
| | KWH | US$ | US$ | |
| 1970 | 182,500 | 0.042 | 7,670 | 500 KWH/Day x 365 days = 182,500 KWH/year |
| 1971 | | 0.043 | 7,850 | Unit charge of electricity per 1 KWH = Rs.0.20 = US$0.042 |
| 1972 | | 0.045 | 8,290 | 182,500 KWH x US$0.042 = US$7,665 |
| 1973 | | 0.047 | 8,580 | |
| 1974 | | 0.049 | 8,940 | Escalation 4% annum |
| 1975 | | 0.051 | 9,330 | |
| 1976 | | 0.053 | 9,670 | |
| 1977 | | 0.055 | 10,040 | |
| 1978 | | 0.057 | 10,400 | |
| 1979 | | 0.060 | 10,950 | First stage works are completed |
| 1980 | | 0.062 | 11,320 | |
| 1981 | | 0.065 | 11,860 | |
| 1982 | | 0.067 | 12,230 | |
| 1983 | | 0.070 | 12,780 | |
| 1984 | | 0.073 | 13,320 | |
| 1985 | 182,500 | 0.076 | 13,870 | |
| Total | | | 167,100 | |

## 6.3 Interest and Amortization of Loans

The project of water supply in Islamabad is a national problem, because the construction of the capital city was started and has been performed on the basis of national government finance. This project requires a huge amount of construction fund, and further more the water supply business which needs an enormous advance investment is hardly to be operated on a self-supporting basis. Hence, special measures must be taken for securing soft funds. From this stand point, it was taken as an appropriate and necessary assumption to obtain foreign loans for foreign currency and local fund free of interest payment and amortization.

### 6.3.1 Interest of Loans

(a) Foreign Fund

Foreign loans to Pakistan in the past have been made at fairly favorable terms, but it cannot be concluded that loans in the future can be secured at such terms. For this proposal, taking into consideration the recent raise in World Bank interest rates on loans, the terms were assumed to be as indicated below.

| | |
|---|---|
| Interest rate: | 5.0% |
| Amortization period: | 20 years including 5 years of grace, principal and interest amortized in equal installments. |

(b) Local Fund

For local currency, the fund is assumed grant made by the Central Government. The project is most important in establishing the capital of Pakistan, and the construction of Simly dam requires huge amount of fund and serves for control of flood and also irrigation. Therefore the terms for loans of local currency for this project was assumed as above.

### 6.3.2 Amortization

Based on the loan terms stated above, the amounts of foreign currency to be repaid will be as indicated in Table 6.3-1. No amortization for the local fund is provided because of above said reasons.

Table 6.3-1

Amortization Schedule - Foreign Currency

Note: Interest rate: 5.0%
Amortization period: 20 years after 5 years of grace
Unit: US$

| Principal | 456,000 | | 1,835,000 | | 7,409,000 | | 6,402,000 | | 1,720,000 | | 533,000 | | 278,000 | | 289,000 | | 301,000 | | 313,000 | | 312,000 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Borriwing Year | 1970 | | 1971 | | 1972 | | 1973 | | 1974 | | 1975 | | 1976 | | 1977 | | 1978 | | 1979 | | 1980 | | Total | |
| Year | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest | Principal | Interest |
| 1970 | 0 | 11,400 | 0 | | | | | | | | | | | | | | | | | | | | 0 | 11,400 |
| 1971 | 0 | 22,800 | 0 | 45,875 | | | | | | | | | | | | | | | | | | | 0 | 68,675 |
| 1972 | 0 | 22,800 | 0 | 91,750 | 0 | 185,225 | | | | | | | | | | | | | | | | | 0 | 299,775 |
| 1973 | 0 | 22,800 | 0 | 91,750 | 0 | 370,450 | 0 | 160,050 | | | | | | | | | | | | | | | 0 | 645,050 |
| 1974 | 0 | 22,800 | 0 | 91,750 | 0 | 370,450 | 0 | 320,100 | 0 | 43,000 | | | | | | | | | | | | | 0 | 848,100 |
| 1975 | 30,400 | 21,660 | 0 | 91,750 | 0 | 370,450 | 0 | 320,100 | 0 | 86,000 | 0 | 13,325 | | | | | | | | | | | 30,400 | 903,285 |
| 1976 | 30,400 | 20,140 | 122,333 | 87,163 | 0 | 370,450 | 0 | 320,100 | 0 | 86,000 | 0 | 26,650 | 0 | 4,865 | | | | | | | | | 152,733 | 915,368 |
| 1977 | 30,400 | 18,620 | 122,333 | 81,046 | 493,933 | 351,928 | 0 | 320,100 | 0 | 86,000 | 0 | 26,650 | 0 | 9,730 | 0 | 5,058 | | | | | | | 646,666 | 899,132 |
| 1978 | 30,400 | 17,100 | 122,333 | 74,929 | 493,933 | 327,231 | 426,800 | 304,095 | 0 | 86,000 | 0 | 26,650 | 0 | 9,730 | 0 | 10,116 | 0 | 5,268 | | | | | 1,073,466 | 861,119 |
| 1979 | 30,400 | 15,580 | 122,333 | 68,813 | 493,933 | 302,534 | 426,800 | 282,755 | 114,667 | 81,700 | 0 | 26,650 | 0 | 9,730 | 0 | 10,116 | 0 | 10,536 | 0 | 5,478 | | | 1,188,133 | 813,892 |
| 1980 | 30,400 | 14,060 | 122,333 | 62,696 | 493,933 | 277,838 | 426,800 | 261,415 | 114,667 | 75,967 | 35,533 | 25,318 | 0 | 9,730 | 0 | 10,116 | 0 | 10,536 | 0 | 10,956 | 0 | 5,460 | 1,223,666 | 764,092 |
| 1981 | 30,400 | 12,540 | 122,333 | 56,579 | 493,933 | 253,141 | 426,800 | 240,075 | 114,667 | 70,233 | 35,533 | 23,541 | 18,533 | 9,568 | 0 | 10,116 | 0 | 10,536 | 0 | 10,956 | 0 | 10,920 | 1,242,199 | 708,205 |
| 1982 | 30,400 | 11,020 | 122,333 | 50,463 | 493,933 | 228,444 | 426,800 | 218,735 | 114,667 | 64,500 | 35,533 | 21,764 | 18,533 | 8,919 | 19,267 | 9,946 | 0 | 10,536 | 0 | 10,956 | 0 | 10,920 | 1,261,466 | 646,203 |
| 1983 | 30,400 | 9,500 | 122,333 | 44,346 | 493,933 | 203,748 | 426,800 | 197,395 | 114,667 | 58,767 | 35,533 | 19,988 | 18,533 | 8,270 | 19,267 | 9,272 | 20,067 | 10,359 | 0 | 10,956 | 0 | 10,920 | 1,281,533 | 583,521 |
| 1984 | 30,400 | 7,980 | 122,333 | 38,229 | 493,933 | 179,051 | 426,800 | 176,231 | 114,667 | 53,033 | 35,533 | 18,211 | 18,533 | 7,622 | 19,267 | 8,598 | 20,067 | 9,657 | 20,867 | 10,772 | 0 | 10,920 | 1,302,400 | 520,304 |
| 1985 | 30,400 | 6,460 | 122,333 | 32,113 | 493,933 | 154,354 | 426,800 | 154,715 | 114,667 | 47,300 | 35,533 | 16,434 | 18,533 | 6,973 | 19,267 | 7,923 | 20,067 | 8,955 | 20,867 | 10,042 | 20,800 | 10,738 | 1,323,200 | 456,007 |
| 1986 | 30,400 | 4,940 | 122,333 | 25,996 | 493,933 | 129,658 | 426,800 | 133,375 | 114,667 | 41,567 | 35,533 | 14,658 | 18,533 | 6,324 | 19,267 | 7,249 | 20,067 | 8,252 | 20,867 | 9,312 | 20,800 | 10,110 | 1,312,000 | 391,441 |
| 1987 | 30,400 | 3,420 | 122,333 | 19,879 | 493,933 | 104,961 | 426,800 | 112,035 | 114,667 | 35,833 | 35,533 | 12,881 | 18,533 | 5,676 | 19,267 | 6,575 | 20,067 | 7,550 | 20,867 | 8,581 | 20,800 | 9,282 | 1,323,200 | 326,673 |
| 1988 | 30,400 | 1,900 | 122,333 | 13,763 | 493,933 | 80,264 | 426,800 | 90,695 | 114,667 | 30,100 | 35,533 | 11,104 | 18,533 | 5,027 | 19,267 | 5,900 | 20,067 | 6,848 | 20,867 | 7,851 | 20,800 | 8,554 | 1,323,200 | 262,006 |
| 1989 | 30,400 | 380 | 122,333 | 7,646 | 493,933 | 55,568 | 426,800 | 69,355 | 114,667 | 24,367 | 35,533 | 9,328 | 18,533 | 4,378 | 19,267 | 5,226 | 20,067 | 6,145 | 20,867 | 7,121 | 20,800 | 7,826 | 1,323,200 | 197,340 |
| 1990 | | | 122,338 | 1,529 | 493,933 | 30,871 | 426,800 | 48,015 | 114,667 | 18,633 | 35,533 | 7,551 | 18,533 | 3,730 | 19,267 | 4,552 | 20,067 | 5,443 | 20,867 | 6,390 | 20,800 | 7,098 | 1,292,805 | 133,812 |
| 1991 | | | | | 493,938 | 6,174 | 426,800 | 26,675 | 114,667 | 12,900 | 35,533 | 5,774 | 18,533 | 3,081 | 19,267 | 3,877 | 20,067 | 4,741 | 20,867 | 5,660 | 20,800 | 6,370 | 1,170,472 | 75,252 |
| 1992 | | | | | | | 426,800 | 5,335 | 114,667 | 7,167 | 35,533 | 3,998 | 18,533 | 2,432 | 19,267 | 3,203 | 20,067 | 4,038 | 20,867 | 4,930 | 20,800 | 5,642 | 676,534 | 36,745 |
| 1993 | | | | | | | | | 114,662 | 1,433 | 35,533 | 2,221 | 18,533 | 1,784 | 19,267 | 2,529 | 20,067 | 3,336 | 20,867 | 4,199 | 20,800 | 4,914 | 249,729 | 20,416 |
| 1994 | | | | | | | | | | | 35,538 | 444 | 18,533 | 1,135 | 19,267 | 1,854 | 20,067 | 2,634 | 20,867 | 3,469 | 20,800 | 4,186 | 135,067 | 13,722 |
| 1995 | | | | | | | | | | | | | 18,538 | 487 | 19,267 | 1,180 | 20,067 | 1,931 | 20,867 | 2,739 | 20,800 | 3,458 | 99,539 | 9,795 |
| 1996 | | | | | | | | | | | | | | | 19,262 | 506 | 20,067 | 1,229 | 20,867 | 2,008 | 20,800 | 2,730 | 80,996 | 6,473 |
| 1997 | | | | | | | | | | | | | | | | | 20,062 | 527 | 20,867 | 1,278 | 20,800 | 2,002 | 61,279 | 3,807 |
| 1998 | | | | | | | | | | | | | | | | | | | 20,862 | 548 | 20,800 | 1,274 | 41,662 | 1,822 |
| 1999 | | | | | | | | | | | | | | | | | | | | | 20,800 | 546 | 20,800 | 546 |
| 2000 | | | | | | | | | | | | | | | | | | | | | | | (1970-1985) | (1970-1985) |
| Total | 456,000 | 267,900 | 1,835,000 | 1,078,065 | 7,409,000 | 4,352,790 | 6,402,000 | 3,761,351 | 1,720,000 | 1,010,500 | 533,000 | 313,140 | 278,000 | 119,191 | 289,000 | 123,912 | 301,000 | 129,057 | 313,000 | 134,202 | 312,000 | 133,770 | 10,725,862 | 9,944,128 |

6.4 Unit Cost of Supplied Water

Unit cost of supplied water from 1970 to 1985 (for 16 years) is calculated as follows:

A. Total Cost

| | | |
|---|---|---|
| 1. Operation and Maintenance cost | ........... | US$ 2,533,533 |
| 1) Personnel expenditure | " | 1,737,100 |
| 2) Miscellaneous expenses | " | 347,420 |
| 3) Repair expenses | " | 173,710 |
| 4) Chlorine and chemical cost | " | 108,303 |
| 5) Cost of electricity | " | 167,000 |
| 2. Interest Payment | ....................... | US$ 9,944,128 |
| Interest for foreign currency | | |
| 3. Depreciation | ............................ | US$10,755,000 |
| TOTAL (1+2+3) | | US$23,232,661 .... A |

B. Total Accounted Water (for 16 years) 67,820,231,000 gallons .... B

C. Unit Cost of Water Supplied

$$\frac{A}{B} = \frac{23,232,661}{67,820,231,000} = \text{US\$0.34/1,000 gallons} = \text{Rs.1.62/1,000 gallons}$$

6.5 New Water Rate

In order to make the cost and revenue ballance, a new tariff of charge as calculated above should be established, effective as from 1970, supposing the new project is started in the same year.

During the first stage works period, the new rate, which seems to be within the capacity of consumers to pay, should yield an average gross revenue of Rs.1.62 per 1,000 gallons of water consumed.

Would the proposed first stage works be executed as scheduled, the revenue from the new water rate would enable CDA to cover its operation and maintenance expenses including depreciation.

# CHAPTER 7

# FINANCING OF THE PROJECT

## CHAPTER 7

## FINANCING OF THE PROJECT

In the preceeding Chapters, existing facilities and future water demand were studied and analyzed. And as a result of these studies and analyses, a construction program was drawn out. The construction of new facilities requires a sizable amount of funds in both local and foreign currencies.

Availability of funds may necessitate modification of construction schedule. For one thing, the amount of available funds must be made sure before everything. For second, terms and conditions of funds must be acceptable to this project. When these are not satisfied, the schedule of construction must be accordingly changed.

In this chapter all these problems are briefly discussed.

A few of important assumptions which were employed in estimating non-operating costs are as follows:

(1) Local fund for construction be a grant by the Government of Pakistan.

(2) Terms and conditions of foreign loans be same as the loan by bilateral assistance program of Japan.

(3) Average life of all the facilities be 50 years.

### 7.1 Fund Requirement

The total construction cost of Rehabilitation Works and First Stage Works as stated in Chapter 6 will be foreign currency equivalent to be US$19,848,000 and US$16,267,000 in local currency or a total of US$36,115,000 and the annual fund requirement is given below.

| Year | Total | Foreign Currency | Local Currency | Remarks |
|---|---|---|---|---|
| 1970 | 502,000 | 456,000 | 46,000 | |
| 1971 | 4,720,000 | 1,835,000 | 2,885,000 | |
| 1972 | 11,627,000 | 7,409,000 | 4,218,000 | |
| 1973 | 11,522,000 | 6,402,000 | 5,120,000 | |
| 1974 | 4,564,000 | 1,720,000 | 2,844,000 | |
| 1975 | 827,000 | 533,000 | 294,000 | |
| 1976 | 506,000 | 278,000 | 228,000 | |
| 1977 | 434,000 | 289,000 | 145,000 | |
| 1978 | 452,000 | 301,000 | 151,000 | |
| 1979 | 470,000 | 310,000 | 157,000 | |
| 1980 | 491,000 | 312,000 | 179,000 | |
| Total | 36,115,000 | 19,848,000 | 16,267,000 | |

Note: Figures include escalation 4% annum.

7.2 Financing of Funds

In general, it is desirable for water supply projects with slow speed of capital rotation to be carried out using long-term, low-interest fund. However, since it is difficult to procure such long-term, low interest funds in the domestic financial market of a developing nation, it was assumed that for this water supply works foreign currency fund requirements would be met by foreign loans and local currency requirements by Pakistan Government funds. CDA is an autonomous body for carrying out development of Capital. The annual budget is subject to the approval of the Central Government. The accounts of CDA are audited by the Comptroller and Auditor General of Pakistan. CDA has to submit annual progress report and such other reports as may be required by the Central Government.

In the light of the purpose of the project, it would be possible for foreign loans and government funds to be secured.

Foreign currency requirement:

Example of loans obtained from foreign countries of this type in Pakistan currently are the World Bank loans and the West German Government loans. The terms of World Bank loan (International Development Association) has been 3.5% interest with the amortization period 30 years including grace period.

If this project of water supply in Islamabad is financed by loans from the Japanese Government, the terms contemplated will be an interest rate of about 5% and the amortization period 20 years including a grace of 5 years, but it cannot be concluded that loans in the future can be secured at such terms.

7.3 Financial Forecast

In order to make certain of financial soundness of the project, a few approaches are to be made from various points of view. In this section possibility of repayment of capital cost is studied. To begin with, depreciation is forecast in accordance with the proposed schedule of construction. Depreciation is a component of water cost and it is a source for amortization of the loans. Amount of yearly depreciation varies with the method of depreciation. In this case a method which is currently used in Japan was used.

Next, water sales are estimated, so as to complete a statement of revenue and expenditure.

According to the obtained estimate of revenue and expenditure, a certain amount of surplus is generated in the early years of the project. But in a few years deficit follows.

Finally cash flow is studied. From the table it is clearly known that in some period cash gets short, which means debt service may not be secure, unless some special step is taken. To raise water rate is one remedy for the situation, and temporary governmental assistance may be another solution.

Financial projections had to be made on a number of assumptions. When any of assumptions is changed, financial projections also must be suited to the changed set of assumptions. This must be repeated in the cource of project implementation.

### 7.3.1 Depreciation

The method of depreciation generally adopted in the water supply of Japan is a 10% residual value fixed amount method and this was also adopted for planning the water supply of Islamabad. In this case durable years was assumed to be as indicated below.

Average durable years of water supply facilities 50 years

Depreciation by year is shown in Table 7.3-1.

Table 7.3-1

Depreciation

Note: ii) Average durable years: 50 year
iii) Residual value: 10%

| | | Before 1970 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Construction Cost | Local currency | 9,971,000 | 46,000 | 2,885,000 | 4,218,000 | 5,120,000 | 2,844,000 | 294,000 | 228,000 | 145,000 | 151,000 | 157,000 | 179,000 | 26,238,000 |
| | Foreign currency | - | 456,000 | 1,835,000 | 7,409,000 | 6,402,000 | 1,720,000 | 533,000 | 278,000 | 289,000 | 301,000 | 313,000 | 312,000 | 19,848,000 |
| Total | | 9,971,000 | 502,000 | 4,720,000 | 11,627,000 | 11,522,000 | 4,564,000 | 827,000 | 506,000 | 434,000 | 452,000 | 470,000 | 491,000 | 46,086,000 |
| Year of depreciation | | | | | | | | | | | | | | |
| 1970 | | 179,478 | | | | | | | | | | | | 179,478 |
| 1971 | | 179,478 | 9,036 | | | | | | | | | | | 188,514 |
| 1972 | | 179,478 | 9,036 | 84,960 | | | | | | | | | | 273,474 |
| 1973 | | 179,478 | 9,036 | 84,960 | 209,286 | | | | | | | | | 482,760 |
| 1974 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | | | | | | | | 690,156 |
| 1975 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | | | | | | | 772,308 |
| 1976 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | | | | | | 787,194 |
| 1977 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | | | | | 796,302 |
| 1978 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | | | | 804,114 |
| 1979 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | 8,136 | | | 812,250 |
| 1980 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | 8,136 | 8,460 | | 820,710 |
| 1981 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | 8,136 | 8,460 | 8,838 | 829,548 |
| 1982 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | 8,136 | 8,460 | 8,838 | 829,548 |
| 1983 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | 8,136 | 8,460 | 8,838 | 829,548 |
| 1984 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | 8,136 | 8,460 | 8,838 | 829,548 |
| 1985 | | 179,478 | 9,036 | 84,960 | 209,286 | 207,396 | 82,152 | 14,886 | 9,108 | 7,812 | 8,136 | 8,460 | 8,838 | 829,548 |
| Total | | 2,871,648 | 135,540 | 1,189,440 | 2,720,718 | 2,488,752 | 903,672 | 148,860 | 81,972 | 62,496 | 56,952 | 50,760 | 44,190 | 10,755,000 |

7.3.2 Revenue from Water Sales

At present the water rate is Rs.1.00 per 1,000 gallon in water supply of Islamabad, but for estimation of revenues the rate was assumed as calculated in Section 6.4, that is, Rs.1.62 per 1,000 gallons.

Revenue from water sales is calculated in Table 7.3-2.

Table 7.3-2

Revenue from Water Sales

| | | Water rate is US$0.34 (Rs.1.62 per 1,000 gallons |
|---|---|---|
| Years | Water Consumption Thousand Gallons per Year | Revenue US$ |
| 1970 | 1,368,750 | 465,375 |
| 1971 | 1,664,181 | 565,821 |
| 1972 | 1,966,839 | 668,725 |
| 1973 | 2,276,724 | 774,086 |
| 1974 | 2,593,836 | 881,905 |
| 1975 | 2,918,175 | 992,179 |
| 1976 | 3,152,150 | 1,071,731 |
| 1977 | 3,593,790 | 1,221,888 |
| 1978 | 3,943,095 | 1,340,652 |
| 1979 | 4,300,065 | 1,462,022 |
| 1980 | 4,664,700 | 1,585,998 |
| 1981 | 5,448,209 | 1,852,391 |
| 1982 | 6,247,304 | 2,124,083 |
| 1983 | 6,845,174 | 2,327,359 |
| 1984 | 7,904,239 | 2,687,441 |
| 1985 | 8,833,000 | 3,003,220 |
| Total | 67,820,231 | 23,024,875 |

Table 7.3-4 Statement of Cash Flow

| Year | Sources: Borrowing | | Sources | | | Application | | | | Balance | Comulative Balance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Local Fund | Foreign Fund | Reserve for Deprecia-tion | Surplus of Operating Expenses | Total | Construction Cost | Amortization of Principal | Deficit of Operating Expenses | Total | | |
| 1969 | 9,971,000 | | | | 9,971,000 | 9,971,000 | | | 9,971,000 | 0 | 0 |
| 1970 | 46,000 | 456,000 | 179,478 | 202,620 | 884,098 | 502,000 | | | 502,000 | 382,098 | 382,098 |
| 1971 | 2,885,000 | 1,835,000 | 188,514 | 235,530 | 5,142,044 | 4,720,000 | | | 4,720,000 | 422,044 | 804,142 |
| 1972 | 4,218,000 | 7,409,000 | 273,474 | 16,901 | 11,917,375 | 11,627,000 | | | 11,627,000 | 290,375 | 1,094,517 |
| 1973 | 5,120,000 | 6,402,000 | 482,760 | | 12,004,760 | 11,522,000 | | 453,233 | 11,975,233 | 29,527 | 1,124,044 |
| 1974 | 2,844,000 | 1,720,000 | 690,156 | | 5,254,156 | 4,564,000 | | 759,991 | 5,323,991 | Δ 69,835 | 1,054,209 |
| 1975 | 294,000 | 533,000 | 772,308 | | 1,599,308 | 827,000 | 30,400 | 810,013 | 1,667,413 | Δ 68,105 | 986,104 |
| 1976 | 228,000 | 278,000 | 787,194 | | 1,293,194 | 506,000 | 152,733 | 763,854 | 1,422,587 | Δ 129,393 | 856,711 |
| 1977 | 145,000 | 289,000 | 796,302 | | 1,230,302 | 434,000 | 646,666 | 612,279 | 1,692,945 | Δ 462,643 | 394,680 |
| 1978 | 151,000 | 301,000 | 804,114 | | 1,256,114 | 452,000 | 1,073,466 | 490,303 | 2,015,769 | Δ 759,655 | Δ 365,587 |
| 1979 | 157,000 | 313,000 | 812,250 | | 1,282,250 | 470,000 | 1,188,133 | 336,467 | 1,994,600 | Δ 712,350 | Δ1,077,937 |
| 1980 | 179,000 | 312,000 | 820,710 | | 1,311,710 | 491,000 | 1,223,666 | 202,054 | 1,916,720 | Δ 605,010 | Δ1,682,947 |
| 1981 | | | 829,548 | 101,610 | 931,158 | | 1,242,199 | | 1,242,199 | Δ 311,041 | Δ1,993,988 |
| 1982 | | | 829,548 | 426,138 | 1,255,686 | | 1,261,466 | | 1,261,466 | Δ 135,780 | Δ1,999,768 |
| 1983 | | | 829,548 | 681,998 | 1,511,546 | | 1,281,533 | | 1,281,533 | 230,013 | Δ1,769,755 |
| 1984 | | | 829,548 | 1,094,176 | 1,923,724 | | 1,302,400 | | 1,302,400 | 621,324 | Δ1,148,431 |
| 1985 | | | 829,548 | 1,463,335 | 2,292,883 | | 1,323,200 | | 1,323,200 | 969,683 | Δ 178,748 |
| Total | 26,238,000 | 19,848,000 | 10,755,000 | 4,220,308 | 61,061,308 | 46,086,000 | 10,725,862 | 4,428,194 | 61,240,056 | Δ 178,748 | |

Note: Δ : deficit
Unit US$

# ANNEXES

## ANNEXES

| | | |
|---|---|---|
| ANNEX | - 1 | Rate for Water Charges and Water Meters in Islamabad |
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| ANNEX | - 3 | Islamabad Residential Sectors, Zoning Regulation |
| ANNEX | - 4 | Water Requirements of Park Division |
| ANNEX | - 5 | Some Questions in Design of Simly Dam |

ANNEX - 1

Rate for Water Charges and Water Meter in ISLAMABAD

I Rate for Water Charges:

1. Govt. servants occupying Govt. quarters or provided requisitioned houses in Islamabad.

a) Metered Supply

A metered supply shall be charged @00.60 per 1000 gallons of water consumed (subject to a minimum of the flat rates as at para (b) below). Where water meters are damaged or defective, recoverly shall be based on the last 3 months average consumption or the flat rates whichever is more.

b) Un-metered Supply

Quarters where no meters have yet been fixed shall be charged at following rates:

| | | | |
|---|---|---|---|
| "A to C" | type | - | Rs. 3/- P.M. |
| D | " | - | Rs. 4/- P.M. |
| E | " | - | Rs. 5/- P.M. |
| F | " | - | Rs. 7/- P.M. |
| G | " | - | Rs. 8/- P.M. |
| H | " | - | Rs.10/- P.M. |
| I | " | - | Rs.12/- P.M. |

(Note: Class IV Govt. servants are exempted from payment of water charges.)

2. Private Houses

a) Metered Supply

i) For domestic use

Water charges will be recovered @ Rs. 1/- per 1000 gallons of water consumed as per meter readings subject to a minimum of the rates as at para (f) below plus motor rent as mentioned in para (iii) above.

ii) Metered supply for construction purposes

Water charges for construction of a house shall be charged @ Rs. 1/- per 1000 gallons of water consumed as per meter readings. The minimum charges shall be as laid down in sub para (b) below.

b) Unmetered supply for construction purpose

Rates of water charges:

| | | | |
|---|---|---|---|
| 1) | Plot measuring | less than 250 sq. yds. | Rs. 100/- |
| 2) | " " | 250 to 500 sq. yds. | Rs. 200/- |
| 3) | " " | 500 to 1000 sq. yds. | Rs. 350/- |
| 4) | " " | 1000 to 12000 sq. yds. | Rs. 400/- |
| 5) | " " | 1200 to 1500 sq. yds. | Rs. 500/- |
| 6) | " " | 1500 to 2000 sq. yds. | Rs. 650/- |
| 7) | " " | 2000 and above. | Rs. 750/- |

(Note: Date of completion of construction of a house will be deemed to be the data of submission of completion certificate or the date of its occupation whichever is earlier.)

c) Partly metered and partly un-metered supply for constn. purposes

Where the supply was partly metered and partly un-metered, the charges for un-metered period shall be recovered on the basis of average monthly rate to be calculated on the 3 months consumption as per meter readings. Provided the total charges thus calculated for the construction period shall not be less than those laid down for un-metered supply for similar size of house in item (b) above.

d) Un-metered supply for construction of Industrial/Commercial Buildings

Shall be recovered @ 1-1/2% of the capital cost of the building as assessed by the DMA.

e) Unmetered supply for construction upto plinth level

Shall be assessed @1/10th of the rate proportionate to the size of the building.

f) Un-metered supply for domestic purposes

In cases where meters were not installed or if installed, became defective during the construction period or immediately thereafter or where the average rate per month cannot be worked out for obvious reasons, charges for water will be charged as under:

i) Rates of water charges

| | | | |
|---|---|---|---|
| 1) | Plots measuring | less than 250 sq. yds. | Rs. 5/- |
| 2) | " " | 250 to 500 sq. yds. | 8/- |
| 3) | " " | 500 to 1000 sq. yds. | 10/- |
| 4) | " " | 1000 to 1200 sq. yds. | 15/- |
| 5) | " " | 1200 to 1500 sq. yds. | 18/- |

| | | |
|---|---|---|
| 6) | Plots measuring 1500 to 2000 sq. yds. | Rs.20/- |
| 7) | " " 2000 and above. | 25/- |

ii) Partly metered and partly unmetered supply of water

Where supply of water is partly metered and partly unmetered, the charges for unmetered period shall be calculated on the basis of 3 months average consumption of water as per meter readings where such average can be worked out. Alternatively, water supply for unmetered period shall be recovered at flat rates laid down in item (i) above.

Water charges recoverable from Public Works Department on account of water consumed on their works at Islamabad e.g. schools, colleges, policlinic, Govt. Press etc. shall be as for our own works viz. 1-1/2% of construction cost.

3. Unmetered supply for Commercial/Industrial enterprises

Where no meters are installed or the ones installed are defective and average rate cannot be worked out for obvious reasons, shall be charged at the following flat rates:

| | | |
|---|---|---|
| 1) | Shops single | Rs. 4/- P.M. |
| 2) | Shops-com-Flats | 8/- P.M. |
| 3) | Hamams | 16/- P.M. |
| 4) | Small Hotels | 16/- P.M. |
| 5) | Melody Cinema (Airconditioning unit) | 100/- P.M. |
| 6) | G.T.S. Bus Station | 32/- P.M. |
| 7) | Kamran Market | 32/- P.M. |
| 8) | Food Market | 32/- P.M. |
| 9) | Covered Bazar | 50/- P.M. |
| 10) | Cooperative Market | 32/- P.M. |
| 11) | Relegious places, Mosques, public parks, playgrounds, fire station, public taps | Free |
| 12) | Laundries including Dhobi Ghat (per stone) | 16/- P.M. or Rs. 5/- per Dhobi which ever is more. |
| 13) | Petrol Pumps | 50/- P.M. |
| 14) | Supplies through public hydrants | Free |
| 15) | i) Small Industry | 125/- P.M. |
| | ii) Big Industry | 250/- P.M. |
| 16) | Supplies through Water Tankers for construction | 10/- per trip per tanker |

II Rates for Water Meters

i) Connection Charges

Will be realized at the following rates:

| | | |
|---|---|---|
| 1/2" size connection | Rs. 90/- | Already approved by the Board of CDA & intimated by Dy. Dir (Water Divn) vide his letter No. DW-11 (31)/68, dt. 18.5.68. Action: D/Maint |
| 3/4" " " | Rs. 120/- | |
| 1" " " | Rs. 250/- | |
| 1-1/2" " " | Rs. 500/- | |

(Note: Water connections may be removed temporarily at the request of a consumer and water meter withdrawn. A fee of Rs. 15/- to cover the cost of labour etc. will be charged for re-connection.)

ii) Water Meters security charge

Will be realized as under:

| | | |
|---|---|---|
| 1/2" size connection | Rs. 80/- | Existing rates being charged by Maintenance Division |
| 3/4" " " | 80/- | |
| 1" " " | 80/- | |
| 1-1/2" " " | 165/- | |

(Note: Water meters shall remain the property of the Authority. Cost of necessary repair/replacement shall be borne by the Authority, unless the Director Maintenance has reasons to prove that damage or defect in meter was due to reasons other than fair wear & tear in which case actual cost of repair/replacement, as reported by Director Maintenance shall be recovered from defaulters.)

iii) Rent of meters shall be charged as under:

| | | |
|---|---|---|
| 1/2" ¢ meters | Rs. 1/- P.M. | Already approved by the Board of CDA. |
| 3/4" ¢ meters | 1/- P.M. | |
| 1" ¢ meter | 1/- P.M. | |
| 1-1/2" ¢ meters | 1/- P.M. | |
| 3" ¢ meters | 16/55P.M. | |
| 6" ¢ meters | 32/75P.M. | |

(Note: i) Rent of meters shall be charged from Govt. Swrvants;

ii) Water meters may be checked at the request of consumer on payment of a fee of Rs. 10/-. If on checking the the meter is found recording defective readings by 5% more or less, the fee so deposited will be refunded.)

The recommendations of the water committee were approved in August, 1969 with the following conditions/amendments:

i) The meter should be installed about one foot higher from the ground level, with in the boundary walls of a house.

ii) The Maintenance Directorate should take at random sample of 10 damaged/out of service meters and repair them. If the repair cost is economical and the results are satisfactory, then only the large scale repair work should be taken in hand.

iii) The rate shown under 2(b) of Rate of water charge would be for the entire period of construction.

iv) The cost of construction for the purpose of item 2(d) of Rate of water charge would be assessed by the Architecture Directorate or the Architect as the case may be.

v) A separate summary for the water charges in respect of Government construction should be put pu.

vi) Water charges (un-metered) for Service Station for motor vehicles should be raised to Rs. 50/- as against the proposed rate of Rs. 32/- per month.

vii) The proposed rate of Rs. 10/- per trip per tanker is to be applicable only for occasional and additional demands.

ANNEX - 2 ISLAMABAD

Diplomatic Enclave

Zoning Regulation 1963

CONTENTS

## CAPITAL DEVELOPMENT AUTHORITY

In exercise of the powers conferred by section 51 of the Capital Development Authority Ordinance, 1960 (XXXIII of 1960), the Authority hereby makes the following Regulation, as being expedient:-

### CHAPTER I - PRELIMINARY

1. Short tile, extent and commencement

(1) This Regulation may be called the Islamabad Diplomatic Enclave Zoning Regulation, 1963.

(2) It extends to the Diplomatic Enclave as defined in this Regulation.

(3) It shall come into force at once.

2. Definitions

In this Regulation, unless there is anything repugnant in the subject or context,

(1) "Ancillary building" means a building subservient to the principal building on the same lot;

(2) "Ancillary use" means a use subservient to the principal use on the same lot;

(3) "Attached building" means a building which is joined to another building at one or more sides by a party wall or walls;

(4) "Authority: means the Capital Development Authority as defined in the Capital Development Authority Ordinance, 1960;

(5) "Basement" means the lowest portion of a building, partly or wholly below ground level;

(6) "Building" means any structure or enclosure permanently affixed to the land;

(7) "Cancery" means a building meant for use as offices by a diplomatic mission;

(8) "Corner lot" means a lot situated at the intersection of two vehicular streets;

(9) "Detached building" means a building which is not an attached building;

(10) "Diplomatic Enclave" means the southern portions of Sectors G-5 and G-4 respectively of Islamabad, bounded on the north by the administrative portion of Sector G-5 and the open spaces parks of Sector G-4, separated by a principal road; on the south by the Murree Highway;

on the west by the portion of Sector G-5 reserved for public buildings, separated by a major road; and on the east by Sector G-3;

(11) "Embassy" means a building meant for use as the residence of the head of a diplomatic mission, his family and servants and which is not a chancery;

(12) "Family" means a group of persons related by blood or marriage, and if not so related, of not more than five persons living together and maintaining a common household;

(13) "Floor area" means (for purposes of determining the floor area ratio) the sum of the gross horizontal areas of the several floors measured from the exterior faces of the exterior walls or from the centre line of the walls separating two buildings excluding the areas (if any) of -

i) Basements;

ii) roof projection upto 3 ft. provided they are designed for architectural beauty or protection against weather and are not utilized for any other purpose whatsoever;

iii) contilever porches upto a maximum depth of 6 ft. provided that a clear yard of the minimum width of 10 ft. is kept from the plot line and such porches are designed for architectural beauty or protection against weather only and are not utilized for any other purpose whatsoever.

(14) "Floor Area Ratio" (F.A.R) means the floor area of a building or buildings on a lot divided by the area of that lot;

(15) "Lot" means a single tract of land on which principal buildings and buildings ancillary thereto may be constructed under the provisions of this Regulation;

(16) "Mezzanine floor" means a balcony inside a room with no access to it except from inside such room;

(17) "Non-conforming use" means any use of land, building or structure which does not comply with the provisions of this or any other regulation governing the use applicable to the area where such land, building or structure is located;

(18) "Principal building" means a building in which the principal use is authorized or permitted;

(19) "Principal use" means the main use of land or building as distinguished from a subordinate or ancillary use;

(20) "Public open space" means any open area including parks, playgrounds, waterways, streets etc. meant for public use;

(21) "Residential building" means a building authorized for residential occupancy by one family.

(22) Being deleted.

(23) "Storey" means the portion of a building included between the surface of any floor and the surface of the floor next above, or if there be no floor above, the space between the floor and the ceiling next above;

(24) "Street" means a way, having houses on one or both sides, which affords a primary means of access to abutting property;

(25) "Structural alteration" means any change in the structure of a building, i.e., supporting parts of a building such as load-bearing walls, columns, beams, slabs, floors and girders;

(26) "Use" means the purpose for which the land or building thereon is authorized or permitted under this Regulation;

(27) "Yard" means an open space on a lot unobstructed from its lowest level to the sky.

(28) "Zones" are the internal divisions of the Diplomatic Enclave.

## CHAPTER II - BUILDINGS AND USES

3. Authorized uses

(1) The following buildings and uses only are authorized by this Regulation:

(a) in zone G5-41-

(i) chanceries and embassies with ancillary buildings related thereto;

(ii) temporary buildings for construction purposes for a period not exceeding the period of duration of the construction of the principal building on the same lot;

(iii) local open spaces i.e., squares, green verges and green areas along the streets and nullah, off-street parkings and children's playgrounds.

(b) in zones G5-48, G5-45 and G5-46-

(i) residential buildings other than embassies;

(ii) temporary buildings for construction purposes for a period not exceeding the period of duration of the construction of the principal building on the same lot;

(iii) local open spaces i.e., squares, green verges, off-street parkings and children's playgrounds.

(c) in zone G5-42 Centre-

administrative buildings; police posts; telephone, telegraph and post offices; telephone exchanges and booths; banks and currency exchanges; fire brigade stations; installations for various services; petrol filling stations; auto-service stations; taxi stands; bus stop; professional offices; shops; restaurants; cultural and entertainment buildings.

(d) in zone G5-44 Centre-

religious buildings; public gardens, parks and playgounds; kindergarten and primary schools including playgrounds and sports-fields incidental thereto, swimming pools; tea or coffee houses; news stands and shops; shops as designed by the Authority; restaurants; and public toilets.

4. Permissible uses

The Authority may, on applicant on or otherwise and on such conditions as it may impose, permit special uses, such as-

(a) in zone G5-41-

telephone booths mail boxes; sentry boxes; cultural and recreation centre; installations for various services; petrol filling stations; taxi stands; bus stops; parking places and public toilets.

(b) in zones G5-43, G5-45 and G5-46

telephone booths; mail boxes; sentry boxes; cultural and recreational centre; installations for various services; petrol filling stations; taxi stands; bus stops; parking places and public toilets.

(c) in zones G5-42 and G5-44 Centres-

police posts; telephone exchanges and booths; electric substations; water distribution installations and dispensaries; public halls, libraries cultural and entertainment buildings; petrol filling stations; bus stops; and sports grounds and outdoor amusement establishments.

(d) in zone G5-47 Recreational-

public halls, clubs and restaurants; outdoor amusement establishments as per designs prepared or approved by the Authority.

Note: The provisions regarding authorized and permissible uses applicable to zones G5-41, G5-43, G5-45 and G5-46 shall also apply to zone G4-1 according to the plans approved by the Authority.

5. Ban on non-conforming uses

(1) No land or building shall be put to a non-conforming use.

(2) Any building or structure designed or intended for a use not authorized or permitted under this Regulation shall either be removed or convented into a building or structure designed or intended for a use authorized or permitted under this Regulation.

## CHAPTER III - CONSTRUCTION OF BUILDINGS

6. Construction of Buildings

(1) Subject to the provisions of Islamabad Building Regulations, the residential and other buildings may be constructed in the Diplomatic Enclave for being held, used and maintained only for the purpose or purposes authorized or permitted under this Regulation.

(2) No building as aforesaid shall be constructed or enlarged or any structural alteration therein made except in accordance with a plan approved by the Authority.

(3) No building shall be constructed on a lot of an area or frontage lesser than as prescribed below:

| Kind of building | Zone | Area in aq. yds. | Frontage |
|---|---|---|---|
| Chanceries and Embassies | G5-41 and<br>G4-1 | 2400 | 120' |
| Other residences | G5-43<br>G5-45<br>G5-46 and<br>G4-1 | 1200 | 60' |

7. Sizes, etc. of buildings

(1) The maximum built-up area of buildings (Principal + Ancillary) on a lot, the F.A.R. and the minimum distance from the lot lines shall conform to the following requirements:

| Kind of building | Zone | Floor Area Ratio (F.A.R.) | Maximum built-up area on the ground | *Minimum distance allowed from | | |
|---|---|---|---|---|---|---|
| | | | | Front lot line | Side lot line | Rear lot line |
| Chanceries and Embassies | G5-41 | 0.8-1.0 | 40% | 30' | 20' | 30' |
| Other residences | G5-43 G5-45 & G5-46 | 0.3-0.6 | 30% | 20' | 10' | 20' |
| Chanceries, Embassies and other residences | G4-1 | | | | | |
| (a) Chanceries & Embassies | | 0.8-1.0 | ** | ** | ** | ** |
| (b) Other residences | | 0.3-0.6 | ** | ** | ** | ** |

* The actual building lines will, however, be fixed by the Authority according to the planning requirements of the zone.

* The detailed plans received from the Diplomatic Mission will be considered by the Authority for approval.

Note 1 - In zones G5-42 and G5-44 (Centres), the maximum built-up area shall not exceed 50% of the area of a plot and the floor area ratio (F.A.R.) shall be 0.8-1.0.

Note 2 - In zone G5-47 (Recreational), the maximum built-up area shall not exceed 10% of the area of a plot and the floor area ratio (F.A.R.) shall be approved by the Authority in each case.

Note 3 - No swimming pool shall be provided in Zones G4-1, G5-41, G5-45 or G5-46.

8. Number of storeys and height of buildings

Subject to the provisions of paragraph 7, the maximum number of storeys and the maximum height of buildings in the various zones shall conform to the following requirements:

| Kind of buildings | Zone | *Maximum number of storeys | *Maximum height in feet |
|---|---|---|---|
| Chanceries and Embassies | G5-41 & G4-1 | Four | 54 |
| Other residences | G5-43 G5-45 G5-46 & G4-1 | Three | 42 |

* This refers to the maximum number of storeys and maximum heights. The actual number of storeys and heights will, however, be fixed by the Authority according to the planning requirements of the zone. Maximum height in single storey buildings shall not exceed 18 feet.

8-A. Power to give directions

Not withstanding anything contained in paragraphs 7 and 8, the Authority way, to ensure proper development of Islamabad or any port thereof, give to the owner of a lot such directions, regarding the size, height and number of storeys of buildings, as it may deem fit and the owner shall act in accordance with such directions.

9. Basements

Where ground levels permit, basements may be allowed by the Authority below the ground floor area only for specified purposes.

Note - Basements shall not be counted for purposes of determining the number of storeys or building heights.

10. Ancillary buildings

(1) Ancillary buildings or other structures of a permanent nature may be constructed on lots subject to the following conditions:

(a) surface covered by such buildings or structures is not more than 20% of the maximum lot coverage and their height in no case exceeds that of the principal buildings.

(b) if detached, the minimum distance from the principal buildings is not less than 6 feet; and

(c) such buildings or structures are constructed after the completion of the principal buildings.

(2) Subject to the conditions laid down in clauses (a) and (b) of sub-paragraph (1), ancillary servant quarters with bathroom and W.Cs. shall be constructed along with the principal residential buildings

in accordance with the scales prescribed below:

| Plot area in sq. yds. | Minimum number of* | |
|---|---|---|
| | Servant quarters | Bathroom and W.Cs. |
| 1200 - 2000 | 2 | 1 |
| Above 200 | 3 | 1 |

* This refers to one-family houses. A proportionate increase in the number of servant quarters, etc. will be necessary for houses designed for more than one-family.

In case the servants' quarters are on two floors, a bathroom and W.C. shall be provided for them on each floor.

11. Structures on roofs

No structure on a roof shall exceed the maximum permitted height of a building except:

(a) Chimneys, air-conditioning and other ducts, vents, wind-catchers and stair-towers designed and built to the satisfaction of the Authority.

(b) Light-bearing structures, e.g., structures for the support of tents or mats, etc., or structures required for the support of plant pots of the minimum dimensions.

(c) Radio and television installations

12. Constructions in front yards

No building or other structure shall be constructed in front yards except electric and water pipe installations, decorative garden structures and/or jali screens.

## CHAPTER IV - MISCELLANEOUS

13. Enclosure of lots

A lot may be enclosed as prescribed below:

Chanceries and Embassies

The height of the enclosure shall not exceed 7 ft: upto 4 ft. it shall be constructed of solid material and the remaining 3 ft. of any material not obstructing view.

Other residences

The height of the enclosure shall not exceed 7 ft. which may consist of any material.

Provided that the Authority may, in order to achieve harmony in the neighbourhood, give directions to the owner of a lot to enclose it in such manner as it considers suitable, and the owner shall act in accordance with such directions.

14. Underground water

No person shall exploit underground water except to the extent and in the manner as may, from time to time , be permitted by the Authority.

K. M. CHIMA
C.S.P.
Secretary
Capital Development Authority

Rawalpindi,
Dated, the 23rd April, 1963

ANNEX - 3 ISLAMABAD

Residential Sectors

Zoning Regulation 1967

CONTENTS

CAPITAL DEVELOPMENT AUTHORITY

In exercise of the powers conferred by section 51 of the Capital Development Authority Ordinance, 1960 (XXIII of 1960), the Authority hereby, in supersession of the Islamabad Sector G-6 Zoning Regulation, 1963, and the Islamabad Sector F-6 Zoning Regulation, 1964, makes the following Regulation as being expedient:

## CHAPTER I - PRELIMINARY

1. Short title, extent and commencement

   (1) This Regulation may be called the Islamabad Residential Sectors Zoning Regulation, 1967,

   (2) It extends to all private residential plots in Islamabad allotted by the Authority except those in the Diplomatic Enclave.

   (3) It shall come into force at once.

2. Definitions

   In this Regulation, unless there is anything repugnant in the subject or contect,

   (1) "Ancillary building" means a building subservient to the principal building on the same plot; e.g., servants' quarters, garage;

   (2) "Apartment" means a residential building consisting of one bed room, a combined drawing and dining room, a bathroom, a kitchenette and a store;

   (3) "Attached building" means a building which is joined to another building on one or more sides by a party wall or walls;

   (4) "Authority" means the Capital Development Authority as defined in the Capital Development Authority Ordinance, 1960 (XXIII of 1960);

   (5) "Basement" means a structure wholly below adjacent ground level;

   (6) "Block" means a tract of land bounded by streets or a combination of streets and public parks;

   (7) "Building" means any structure or enclosure permanently affixed to the land;

   (8) "Corner plot" means a plot situated at the intersection of two vehicular streets;

   (9) "Detached building" means a building which is not an attached building;

(10) "Dwelling house" means a residential building for the use of a single family having at least two habitable rooms;

(11) "Family" means a group of persons related by blood or marriage, and, if not so related, of not more than five persons living together and maintaining a common household;

(12) "Flat" means an apartment consisting of two or more bedrooms;

(13) "Floor Area" means (for purposes of determining the floor area ratio) the sum of the gross horizontal areas of the several floors including the thickness of walls, verandahs, porches, 25% of the area covered by pergolas but excluding open staircases whereover permitted, basements, vaults, cellars, chhajjas upto three feet, roof projections upto five feet and cantilever porches not exceeding twenty feet in length and twelve feet in depth provided such projections and porches are designed for architectural beauty or protection against weather only and are not capable of being utilized for any other purpose whatsoever;

(14) "Floor Area Ratio" (F.A.R.) means the floor area of a building or buildings on a plot divided by the area of that plot;

(15) "Home occupation" means a non-residential user which may be carried on wholly within a principal or ancillary building provided that not more than one person outside the family is employed and no offensive noise, vibration, smoke, dust, odour, heat or glare is produced nor the residential character of the building is changed;

(16) "Mezzanine floor) means a balcony inside a room with no access to it except from inside such room;

(17) "Non-conforming use" means any use of land, building or structure which does not comply with the provisions of this or any other regulation governing the use applicable to the area where such land, building or structure is located;

(18) "Plot" means a single tract of land located within a block and demarcated by the Authority as such;

(19) "Party wall" means a common wall between adjacent buildings on independent plots;

(20) "Prescribed" means prescribed by this Regulation or instructions issued by the Authority from time to time;

(21) "Principal building" means a building in which the principal use is authorized or permitted;

(22) "Principal use" means the main use of land or building as distinguished from a subordinate or ancillary use;

(23) "Public open space" means any open area including parks, playgrounds, waterways, streets, etc., meant for public use;

(24) "Residential building" means a building authorized for residential occupancy including flats and apartments where permitted.

(25) "Residential plot" means a plot allotted for a residential building exclusively;

(26) "Semi-detached building" means a building abutting on a side plot line as prescribed by the Authority;

(27) "Storey" means the portion of a building included between the surface of any floor and the surface of the floor next above or, if there be no floor above, the space between the floor and the ceiling next above;

(28) "Street" means a way, having houses on one or both sides, which affords a primary means of access to abutting property;

(29) "Structural alteration" means any change in the structure of a building, i.e. supporting members of a building such as load-bearing walls, columns, beams, slabs, floors and girders;

(30) "Terraced houses" means contiguous houses constructed on adjacent plots, separated by party walls and having no side yard;

(31) "Use" means the purpose for which the land or building thereon is authorized or permitted under this Regulation;

(32) "Yard" means an open space on a plot extending along the full length of the relevant plot line and unobstructed from its lowest level to the sky.

## CHAPTER II - BUILDINGS AND USES

### 3. Authorized buildings and uses

Only the following buildings and uses are authorized by this Regulation:

(a) apartments/flats as permitted in the Schedule;

(b) principal residential building;

(c) ancillary buildings

(d) temporary buildings for construction purposes for the duration of the construction of the principal building on the same plot;

(e) home occupations with the prior permission of the Authority

### 4. Use of plots

No plot shall-

(a) be divided into portions, reduced in the size of any of its dimensions or transferred in portions; or

(b) be amalgamated with an adjoining plot or plots for construction of buildings or for any other purpose whatsoever; or

(c) be provided with a septic tank or swimming/cess/decorative pool of any kind.

5. Ban on non-conforming uses

(1) No land or building shall be put to a non-conforming use

(2) Any building or structure designed or intended for a use not authorized or permitted under this Regulation shall either be removed or converted into a building or structure designed or intended for a use authorized or permitted under this Regulation.

6. Construction of buildings

No building shall be constructed or any addition or alteration therein made except in accordance with this Regulation and the Islamabad Building Regulations.

7. Sizes, heights, number of storeys and type and nature of development of buildings

Except as otherwise prescribed or permitted by the Authority, the maximum built-up area of buildings (principal and ancillary) on a plot, the minimum yard from the plot lines, the maximum number of storeys, the maximum height, the type and nature of development of buildings shall be as laid down in the Schedule:

Provided that the Authority may, in order to achieve harmony in the neighbourhood or to meet the special planning requirements of an area, give directions to the owner of a plot to follow such deviations (including restrictions and relaxations) from the Schedule as the Authority may consider necessary, and the owner shall act in accordance with such directions.

8. Basements, vaults, cellars, etc.

Basements, vaults, cellars and other structures below ground level may be allowed by the Authority for specified purposes only. Provided that in the case of a basement, the minimum height shall be 8 ft. or, as in the opinion of the Authority, conforms to the nature of the use of the space and the roof of the basement may project by not less than 2 ft. but not more than 3 ft. 6 in. above the adjacent ground level (for proper light and ventilation).

9. Ancillary buildings

(1) Ancillary building of a permanent nature may be constructed on a plot subject to the following conditions:

(a) surface covered by such building is not more than 20 per cent of the maximum permissible plot coverage, and its height, in no case exceeds that of the principal building;

(b) if detached, the minimum distance from the principal building is not less than 6 ft.

(2) Subject to the conditions laid down in clauses (a) and (b) of sub-paragraph (1), adequate accommodation for servants shall be provided on each plot and the minimum number of servants' quarters (with amenities) shall be in accordance with the following scales:

(a) for dwelling houses except in Sector G-6:

| Plot area in sq. yds. | *Servants' quarters | Bathrooms | W.CS. |
|---|---|---|---|
| 300 - 500 | 1 | 1 | 1 |
| 501 - 1100 | 2 | 1 | 1 |
| Above 1100 | 3 | 1 | 1 |

(b) for dwelling houses in Sector G-6:

| | | | |
|---|---|---|---|
| 400 - 999 | 1 | 1 | 1 |
| 1000 - 2000 | 2 | 1 | 1 |
| 200 and above | 3 | 1 | 1 |

(c) for apartments and flats, where permitted:

| | | | |
|---|---|---|---|
| per flat of more than two bedrooms | 2 | 1 | 1 |
| per flat of two bedrooms or an apartment | 1 | 1 | 1 |

* In case the servants' quarters are on two floors, at least on bathroom and one W.C. shall be provided on each floor.

10. Structures on roofs

The following structures only, which shall be of a permanent nature, may be constructed on roofs provided they are designed and built to the satisfaction of the Authority:

(a) chimneys, air-conditioning and other ducts, vents and windcatchers

(b) water tanks suitably designed or not visible from the road

(c) radio and television installations

(d) stair-towers provided they improve the elevation

(e) parapet walls of maximum height of 5 feet

(f) a 'barsati' provided it is combined with a stair-tower and a W.C. is attached thereto. The net area of barsati shall not exceed 1/10th of the covered area permitted on the ground floor.

(g) other structures which the Authority may, by general or specific order, permit.

11. Construction in minimum prescribed yards

No building or other structure shall be constructed within the minimum yards prescribed for a plot except:

(a) chhajjas upto three feet

(b) roof projections upto three feet in single storey buildings and upto five feet in multi-storey buildings

(c) cantilever porches not more than:

(i) 9' x 20' where the minimum prescribed width of the yard is 10 feet

(ii) 12' x 20' where the minimum prescribed width of the yard exceeds 10 feet

(d) open staircases as approved by the Authority on the building plans

(e) decorative walls not higher than the compound walls enclosing the plot provided access to the rear/side yard is available

## CHAPTER III - MISCELLANEOUS

12. Enclosure of plots

A plot shall be enclosed by walls and/or hedges as prescribed below:

The height of the enclosure shall not exceed 7 feet: up to 3 feet, it shall consist of solid masonry and the remaining may be of light material or hedge.

13. Underground water

No person shall exploit underground water except to the extent and in the manner as may, from time to time, be permitted by the Authority.

14. Repeals and savings

The Islamabad Sector G-6 Zoning Regulation, 1963 and the Islamabad Sector F-6 Zoning Regulation, 1964 are hereby repealed:

Provided that everything done, action taken, liability incurred or proceeding commenced under the said Regulations, shall be continued and, so far as may be, be deemed to have respectively been done, taken, incurred or commenced under this Regulation and any regulation referring to any of the said provisions shall, as far as may be, be construed to refer to this Regulation or to the corresponding provision thereof.

THE SCHEDULE

| Plot Area in Sq. Yds. | Frontage | Maximum Floor Area Ratio (F.A.R.) | Maximum No. of Storeys and Height | | Maximum Built-up Area on Ground | Minimum Yard | | | | Type of Development |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | Height | | Front | Side | Rear: Principal Building | Rear: Ancillary Building | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | | | | SECTOR F-6 | | | | | |
| 200-500 | Less than 60' | 0.60 | 2 | 30 ft. | 50% | 10' | - | 10' | 10' | Terraced dwelling houses. |
| 501-1100 | " | 0.60 | 2 | 30 ft. | 40% | 10' | 10' | 20' | 10' | Semi-detached dwelling houses. |
| 501-1100 | 60' | 0.60 | 2 | 30 ft. | 40% | 10' | 10',10' | 20' | 10' | Detached dwelling houses. |
| 1100 and | 60'&70' | 0.60 | 2 | 30 ft. | 40% | 20' | 10',10' | 20' | 10' | " |
| above | 80' | 0.60 | 2 | 30 ft. | 40% | 20' | 15',15' | 20' | 10' | " |
| | 90' & above | 0.60 | 2 | 30 ft. | 40% | 20' | 20',20' | 20' | 10' | " |
| | | | | | SECTOR G-6 | | | | | |
| 101-150 | - | 0.60 | 1 | 18 ft. | 60% | 5' | - | 10' | - | Terraced dwelling houses. |
| 151-450 | - | 0.60 | 2 | 30 ft. | 50% | 10' | - | 10' | - | " |
| 451-850 | - | 0.60 | 2 | 30 ft. | 40% | 10' | 10' | 20' | 10' | Semi-detached dwelling houses. |
| 851 and | 60' | 0.60 | 2 | 30 ft. | 40% | 20' | 10',5' | 20' | 10' | Detached dwelling houses. |
| above | 70' | 0.60 | 2 | 30 ft. | 40% | 20' | 10',10' | 20' | 10' | " |
| | 80' | 0.60 | 2 | 30 ft. | 40% | 20' | 15',15' | 20' | 10' | " |
| | 90' & above | 0.60 | 2 | 30 ft. | 40% | 20' | 20',20' | 20' | 10' | " |

SECTORS F-7 & F-8

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 488-599 | 50' | 0.60 | 2 | 30 ft. | 30% | 15' | 5',10' | 10' | 10' | Single/attached/dwelling houses/flats/apartments as prescribed in the notes below. |
| 600-999 | 60' | 0.60 | 2 | 30 ft. | 30% | 15' | 10',10' | 10' | 10' | " |
| 1000-1400 | 70' | 0.60 | 2 | 30 ft. | 30% | 20' | 10',10' | 20' | 10' | " |
| 1022-1800 | 80' | 0.60 | 2 | 30 ft. | 30% | 20' | 15',15' | 20' | 10' | " |
| 1350-1600 | 90' | 0.60 | 2 | 30 ft. | 30% | 30' | 20',20' | 20' | 10' | " |
| 1700-1999 | 100' | 0.60 | 2 | 30 ft. | 30% | 30' | 20',20' | 20' | 10' | " |
| 2000-2300 | 100' | 0.60 | 2 | 30 ft. | 30% | 30' | 20',20' | 20' | 10' | " |

1. Rear yard forancillary buildings on plots, the rear plot line of which abuts on the side plot line of another plot, shall not be less than 20' except when a verandah not more than 10' wide is constructed on that side.

2. In cases where minimum rear yard for ancillary buildings is permitted to be 10', part of yard (in between) ancillary abuilding and rear plot line shall be paved.

3. Type of development refers to individual plots.

3. Type of development refers to individual plots.
   (a) 488 - 1999 sq. yds. - Not more than two dwelling houses/two flats/one flat and two apartments.
   (b) 2000 - 2300 sq. yds. - Not more than four dwelling houses/four flats/four apartments.

4. Overhead tank of adequate capacity should be provided.

5. No ancillary accommodation shall face the main road and the front facade of the principal building on the road side shall be architecturally harmonious with the general architecture of the neighbourhood.

6. In case of the corner plots, the boundary walls at the corners should be chamfered so as to aboid blind corners at the Junction of the two roads.

7. The architects, while submitting the designs of the houses, should also provide garbage storage in keeping with the size of the building.

8. The minimum height of the plinth of a house should be 1' - 6" above the adjacent road level.

9. For a single dwelling house on one plot the maximum built-up area on the ground can be 40% and 20% on the first floor. For single storey dwelling houses on one plot, the maximum built-up area can be upto 40%.

ANNEX - 4

Water requirements of Park Division

I. Area already developed (upto 30.6.1970)

A. Horticulture

1. Rawal Natural Park

The total area is 970 acres with approximately 2,00,000 plants and 50 acres lawns. On the basis of 3" deep irrigation per week, the total daily water requirement of 2,00,000 plants would be 1,40,000 gallons. On the basis of 2" deep irrigation per week, the total requirement of lawns would be 3,15,000 gallons. Hence total requirement of Rawal Park would be 4,55,000 gallons daily.

2. Rawal Triangular Park

The total area is 30 acres with approximately 10,000 plants and lawns over 20 acres. The total daily requirement of plants is 7,000 gallons and of lawns 1,25,000 gallons. The total daily water requirement of plants and lawns would be 1,32,000 gallons.

3. Golf Course

Its area is about 295 acres. As the control of this course has been transferred to the Islamabad Club and its irrigation system is being controlled by them, no arrangement of water is to be made from this Project.

4. Fruit Farm

Its area is about 100 acres. The total daily requirement is 8,00,000 gallons daily.

5. Nullahs in National Sports Centre

The total area is 675 acres. Mostly hardy species have been planted here. The number of plants is 1,00,000. The total daily requirement is 50,000 gallons.

6. Shakarparian Park

The total area is 420 acres. The number of plants is about 75,000. On the basis of 3" deep watering per week, the daily water requirement is 55,000 gallons per day. There are about 50 acres of lawns. On the basis of 2" deep irrigation per week, the daily requirement would be 3,15,000 gallons. For acquaric garden about 10,000 gallons daily would be further required. Hence the total requirement would be 3,80,000 gallons per day.

7. R & J Garden & Eidgah

The total area is 100 acres (50 acres R & J Garden and 50 acres Eidgah). There are about 50,000 plants which also include 14,000 roses and 3,000 jasmines. In addition to this there are 25 acres of lawns and 25,000 Rft. hedge. The total daily requirement of plants is 60,000 gallons and of lawns 3,15,000 gallons. The total requirement would thus be 3,75,000 gallons daily.

Contd: P/2

8. Play fields

The total area is 36 adres. There are about 12 acres under play fields and 24 acres under wood-lands. The total number of plants water requirement of play-fields is approximately 1,08,000 gallons per day. The requirement of plants is 4,000 gallons. Hence the total requirement of water is 1,12,000 gallons daily.

9. Garden Avenue

The total area of Garden Avenue is 105 acres. There are 10,000 plants. On the basis of 3" deep irrigation, the total water requirement is 7,000 gallons per day.

B. Nursery

The total area of Nursery is 35 acres. The total daily requirement of water is approximately 7,75,000 gallons (1-1/2 cusic).

C. Arboriculture

1. Shahrah Islamabad

The total length of this highway is 14.5 miles. The total area so far developed is 1305 acres and the approximately number of plants is 2,75,000. Mostly hardy plants have been introduced. On the basis of 2" deep irrigation per week, the total water requirement is 1,25,000 gallons per day.

2. Shahrah Kashmir

The total length of this highway is 15 miles. The total area so far developed is 700 acres and the approximate number of plants is 2,00,000. Here also mostly hardly plants have been introduced. On the basis of 2" deep irrigation per week, the total water requirement is 95,000 gallons per day.

3. National Park Road

The total length is about 5 miles. So for 70 acres of land have been developed. Approximately 15,000 plants have been introduced. The daily water requirement on the basis of 3" deep irrigation is 10,000 gallons.

Hence total water requirement of areas developed upto 30.6.70 under Horticulture, Nursery and Arboriculture is 32,96,000 gallons per day.

II. Areas to be developed during 1970 - 1975

A. Horticulture

1. Rawal Natural Park

The total area to be developed is 500 acres and the approximate number of plants 1,00,000. On the basis of 3" deep watering per week, the total daily water requirement would be 70,000 gallons.

2. National Sports Centre

The area under this project is approximately 400 acres. Here mainly play-fields, practice grounds with avenue of trees, etc. would be introduced. The approximate area under play-field would be 100 acres and

Approximately 50,000 plants would be grown. On the basis of 3" deep irrigation for play fields per week, the daily requirement would be 7,35,000 gallons. The requirement of plants would be approximately 35,000 gallons. Hence the total requirement would be 7,70,000 gallons per day.

3. Botanical and Zoological Gardens

Although the total area ear-marked for this purpose is more than 1000 acres. But the plans being prepared are for 200 acres. The remaining area, it is learnt, would be treated for growing wood-lands. For the present the water requirement has been worked out for 500 acres. It is a particular type of project, where all sort of plants would be introduced, animals kept and spacious lawns would be prepared. It is estimated that the area under lawns would be 75 acres and there would be about 75,000 plants. The total requirement of lawns would be 4,75,000 gallons daily and there of plants 55,000 gallons daily. The requirement of animals, birds, etc. would be 20,000 gallons. Hence the total requirement would be 5,50,000 gallons per day.

B. Green Belt

1. Shahrah Islamabad

There area approximately 400 acres left-over from the total area of this Highway which would be developed. It is anticipated that

75,000 plants would be grown over this land and the total water requirement would be 40,000 gallons per day.

2. Shahrah Kashmir

There would be apout 1,000 acres which are intended to be developed. The approximate number of plants would be 2,00,000. The total requirement would be 1,00,000 gallons per day.

3. National Park Road

The left over area is approximately 250 acres. About 50,000 plants would be grown. The total water requirement would be 35,000 gallons per day.

4. Northern Half series of H Sedtors (8-12)

The total area of northern half of H series from 8-12 is 2,250 acres. Approximately 4,50,000 plants would be grown. The total daily water requirement would be 2,25,000 gallons.

5. I.J. Principal Road

The total length of this road is 6.5 miles and the total area is 370 acres. About 75,000 plants would be grown. The total daily water requirement is 40,000 gallons.

6. G.T. Road

200' wide strip on both sides of G.T. Road from Polytechnique to Nicholson Monument (10 miles) has been acquired. The total area comes to 480 acres. About 1,00,000 plants would be introduced. The total water requirement would be 50,000 gallons per day. The grand total of daily water requirement of the area to be developed during 1970-75 would be 18,80,000 gallons.

| | | |
|---|---|---|
| I. | G. Total of daily water requirement of areas already developed: | 32,96,000 gallons |
| II. | G. Total of water requirements of areas to be developed: | 18,80,000 " |
| | Grand Total | 51,76,000 gallons |

ANNEX - 5

Some Questions in Design of Simly Dam

In connection with the Feasibility Report of November, 1968, written by Tecsult International, Ltd., regarding the design of Simly Dam for the Islamabad Bulk Water Supply, apparent conflicts and obscurities have been found and difficulties have been in understanding the plans and the feasibility report. Therefore, in view of the nature and magnitude of the dam project, for which rehability and economy are stated to have been taken as the prime considerations, several points are enumerated as follows:

1. With respect to the design of the Dam

(1) Embankment Volume

The total volume of embankment material for dam is 2,600,000 cubic meters, the items making up this total being:

| | | |
|---|---|---|
| (a) | For core and shell zones | 1,600,000 $m^3$ |
| (b) | For filter zones | 500,000 " |
| | (The filter material is specified to be manufactured sand.) | |
| (c) | For rock zones | 500,000 " |

(2) Embankment Material

(a) Core Material

The borrow pits for core material of the construction embankments are stated to be located as distant as seven kilometers from the dam site. Is it an established fact, based on exhaustive exploration, that it is not possible to expect to find sources closer to the dam site?

(b) Filter Material

Since the filter material is specified to be manufactured sand, is it not true that any feasible variation of design that would permit significant reduction of the volume of filter material would be seriously considered by the Owner?

(c) Rock Material

1) The total volume of excavation of overburden and rock material for the overall project will be quite appreciable. Is it definitely decided that advantage can not be taken of this excavated material for the construction of the shells of the embankment in order to avoid costly haulage. Such usage would save the importation of approximately 500,000 cubic meters.

2) Modofication of dam filter zone

If such a modification of the composition of the shells were found possible to yield different pore-pressures, would the present filter-zone concept be modified?

2. With respect to the Spillway

The proposed design of the spillway complicates the entire execution of the works. It requires about twice the amount of concrete needed to construct a more ordinary spillway. Closer investigation might reveal that foundation conditions would permit a simplification of this design and reduction in volume. In view of nature of the site, the flood improbability and other technical conditions, is it not possible that, in the interests of economy, the design of spillway might be significantly modified?

3. With respect to the Diversion Tunnel

The diversion tunnel portal is immediately below the spillway apron, and means that the execution of the blasting of the apron itself is more difficult.

The situation of the outlet portal of the diversion tunnel as an integral part of the spillway chute apron again causes construction problems.

It is intended that the diversion tunnel be used for the purpose of river diversion during the entire dam construction period. This will require that the spillway and apron work be started about two years before the dam embankment since the spillway forms part of the diversion channel. In view of the basic considerations being reliability and economy would, it be possible that the location of diversion tunnel might be changed from the original location to an upstream location, if one could be found? It would be possible to reduce the construction period appreciably if a routing about 400 meters long of the diversion tunnel is chosen and conclude that approximately US$100,000 of cost will be decreased. Would the owner consider such an alternate scheme if investigation proved it feasible?

4. Intake Tunnel

According to the original design intake tunnel is located on the left bank of the dam. The pipe line from the outlet portal is carried across the dam on a berm to the right bank. Such a pipe structure is likely to be fragile, and when it is constructed will be on unsettled dam embankment. The pipe line might be damaged by future settlement of the dam? Accordingly, is there no possibility that the intake tunnel might be relocated on the right bank of the dam?