PART 2

SABAH AND SARAWAK

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1. INTRODUCTION

This Sectoral Report presents a study on:

(1) The present condition of domestic and industrial water demand (D&I water demand) in 1980; and

(2) The future D&I water demand through 2000 in the States of Sabah and Sarawak.

The objectives of this Study lie in providing the following studies with data and information:

(1) The analysis of water balance in each basin to make up water resources development plans including those of D&I water supply in case the water deficit were projected in some river basins; and

(2) The water pollution abatement study through identifying the pollutant source and estimating the pollutant load to be generated in association with D&I water use.

In projecting the future water demand, the result of the socio-economy study in the Study was fully incorporated in respects to population projection, GDP and GRP projections and the projection of gross value of output in manufacturing sector. In projecting industrial water demand, the result of the agricultural study was incorporated in respect to future production projections of oil palm and rubber.

In making the analysis, necessary data were gathered through the relevant ministries and agencies of the Government of Malaysia and state and district authorities during field survey. Some foreign statistics were also referred to for the Sectoral Study including Japanese industrial water use statistics. Major references and data sources are listed in the last page of the text of this Sectoral Report.

2. PRESENT CONDITION OF D&I WATER SUPPLY AND USE IN THE STATE OF SABAH

2.1 Organization

Public water supply in the State of Sabah is administered by the Public Works Department (PWD).

As a whole, PWD supplies pipe water to urban area including major towns and minor towns. PWD supply pipeline extends to some suburban rural areas located in the vicinity of urban towns as well. Almost all the water supplied by PWD is treated through coagulation and sedimentation, rapid gravity filters or pressure filters, and chlorination. The water pipelines are connected to individual taps and public stand pipes are few in Sabah.

The PWD has its Headquarter at Kota Kinabalu and has eight Divisional Office throughout the State including Sandakan, Tawau, Interior, West Coast North, West Coast South, Kudat, Beaufort and Labuan Divisional Offices. As of the end of 1980, PWD administers 25 water works throughout the State.

A new law, the Sabah Water Authority Enactment, passed the State Assembly and was approved by the Governor in April, 1981. When the Sabah Water Authority is activated, it will become a sole statutory body responsible for water supply in Sabah with an independent accounting function.

Untreated water supply in rural areas is made by the State Government under the technical and financial assistances of the Medical and Health Services (MHS) of the Ministry of Health (MOH) of the Federal Government.

Herein these areas are tentatively defined as the MHS rural areas.

In MHS rural areas, untreated water supply facilities are constructed by either withdrawing small river water by gravity up to individual house connections or digging shallow wells equipped with hand pumps. As the water is not treated, the users are suggested to boil the water before drinking.

2.2 Urban Water Supply

2.2.1 PWD urban water supply

In this Study, "urban" area was defined as the urbanized towns whose population in the year of 2000 was estimated in this Study to exceed 10,000 and more. Such towns defined as above were designated as "cities/ towns" in this Study and there are 11 cities/towns in the State of Sabah as shown in Table 1.

In the State of Sabah, PWD provides water for all uses comprising domestic, industrial, commercial and public uses and no separate pipeline specified to industrial use is installed.

In 1980, the daily average water of 94,500 m^3/d was delivered through PWD water works to the estimated population of 293,500 in 11 cities/towns. The location of 11 cities/towns is presented in Fig. 1 and their water supply data in 1980 is as shown in Table 2. The estimated daily per capita supply amounted to 322 liter per capita per day (lpcd) and the consumption is estimated at about 193 lpcd if a UAF ratio is assumed at 40%.

Most of the water sources are rivers. But in Sandakan and Labuan, boreholes are the substantial water sources. In Semporna and Kota Belud, wells are the primary water sources. In Kudat, an impounded reservoir of rainfall storage constructed on a hill near the town is the sole water source.

The historical water supply data of PWD as a whole including rural water supply is as shown in Table 3 for the period from 1970 to 1980. At the beginning of the last decade, the water supply-demand in Sabah was in critical condition; the consumption exceeded the design capacity in 1970 and 1971. Such a condition has been improved rapidly in these 10 years. In the period from 1970 to 1980, the water works increased in number from 16 to 25. The design capacity was expanded from 29,200 m^3/d in 1970 to 124,600 m^3/d in 1980 with a growth rate of 15.6% per annum. The daily water supply increased from 31,000 m^3/d in 1970 to 105,600 m^3/d in 1980 with a growth rate of 13.0% per annum. The population served by piped water increased from 148,400 to 345,100 with a growth rate of 8.8% per annum in the same period. Consequently, the daily per capita supply increased from 210 lpcd in 1970 to 306 lpcd in 1980.

2.2.2 Water supply in major cities/towns in Sabah

(1) Kota Kinabalu

The Moyog river is the sole water source of Kota Kinabalu. There are two intakes on the Moyog river; Kasigui intake and Moyog intake. The Kasigui intake commissioned in 1958 has the total pumping capacity of 15,900 m^3/d with four pumps of centrifugal type. The Moyog intake commissioned in 1973 and situated 7 km upstream of the Kasigui intake has the total pumping capacity of 36,400 m^3/d with two pumps of electrically driver axial flow type. Although the total intake capacity of these two intakes accounts to 52,300 m^3/d, the normal operation is being made at the capacity of 45,500 m^3/d in average.

In 1980, the daily average delivery from the treatment plant was recorded at 42,725 m^3/d. The data of consumption by types of consumer was not available during the field survey. According to the Master Plan Study of Kota Kinabalu Water Supply (Ref. 1), however, in 1974/75, the percentage distribution of water use was estimated based on a detailed analysis of the meter readings as; domestic use including commercial and public uses: 50.3%, industrial use: 9.7% and unaccounted-for (UAF) water: 40.0%.

The served population in 1980 was estimated at 119,000 and the daily per capita consumption was estimated at 215 lpcd assuming the UAF ratio of 40%. Almost all the residents inside the Kota Kinabalu Municipal Council boundary were estimated to be provided by the PWD supply networks and about 53,800 people living in the suburban area of Kota Kinabalu were estimated to be provided water through PWD in 1980.

(2) Sandakan

Water supply in Sandakan depends on 21 boreholes and two river intakes. In terms of supply volume, groundwater occupies 75% of the total supply and the remaining 25% is supplied by river water. There are two treatment plants in operation:

(a) The old treatment plant with a capacity of 5,280 - 6,720 m^3/d is connected with seven boreholes and Kebunchina river intake, and

(b) Sibuga treatment plant with a capacity of 15,600 m^3/d is connected with 14 boreholes and Sibuga river intake.

In 1980, the average daily delivery of 20,500 m^3/d was recorded. The current water demand is estimated by PWD at 27,300 m^3/d and shortages in water supply occur frequently. The normal pressure in water pipeline is maintained for only four hours during the daytime and, at the worst period, the pressure is forced to decrease to 30% of the normal pressure.

An estimated 64,700 people out of the total population of 80,800 are served through the existing system representing 80% of the service factor. Industrial use is estimated at 5,500 - 6,800 m^3/d comprising the demand in the industrial area near Batu Sapi and the Mile 3 North Road. The UA ratio is currently estimated at 20 - 30%; this is mainly due to the old pipelines and undetective water.

(3) Tawau

Water supply in Tawau depends fully on the Tawau river. There are two water works on the Tawau river: Kuhara water works and North Road water works. The Kuhara water works commissioned in 1955 is composed of two raw water pumps and the associated treatment facilities with the design capacity of 2,280 m^3/d. The North Road water works commissioned in 1970 thereafter reinforced in 1975 is composed of two raw water pumps and the associated treatment facilities with the design capacity of 11,380 m^3/d.

The total water demand in Tawau at present is estimated by PWD at about 21,400 m^3/d, which by far exceeds the present capacity of water delivery. Actually, in 1980, the average water delivery from these two water works was recorded at 13,300 m^3/d which exceeds the total design capacity. Under these situations, the water rationing has been experienced in southern part of Tawau since 1979.

According to the data provided by PWD, 35,200 people were estimated to be served through PWD networks in 1980. Based on this data, the service factor is estimated at about 70%. It is informed through interview with PWD officials that the industrial use is estimated to be few in the PWD water supply.

2.3 Rural Water Supply

2.3.1 General

In this study, the "rural" area was defined as the other area than the urban area that was defined in Sub-section 2.2.1. The rural area was divided, as necessary, into "suburban" rural and "isolated" rural; the suburban rural comprises the rural area located in the vicinity of the city/town and is provided water through the supply networks of the town. While, the isolated rural comprises the other interior rural area than the suburban rural area and is broken down in this Study into PWD rural and MHS rural areas for planning purpose.

In respect to water demand, however, that of suburban rural was counted in the urban water demand in this study because the water works of some cities/towns will also provide water to its suburban rural area in the future as they are doing at present.

In this Study, the isolated rural areas are broken down into and called tentatively as the PWD rural area where treated water is supplied through PWD pipeline system and the MHS rural area where untreated water is supplied through the technical and financial assistances of MHS of the Federal MOH.

The present conditions of rural water supply in Sabah are as stated below.

2.3.2 PWD rural water supply

In the rural area in Sabah, the daily average water of 11,100 m^3/d was delivered through 14 PWD water works to the estimated population of 51,600 in 1980. The location of 14 water works is given in Fig. 1 and the water supply data in 1980 is as shown in Table 2. The estimated daily per capita supply amounted to 215 lpcd. The daily per capita consumption was estimated at about 129 lpcd if UAF ratio of 40% was assumed.

Most of the water sources are rivers. But in Kuala Penyu, the sole water source is boreholes. In Beaufort and Tenom, springs constitute the substantial water source and in Kunak, spring are also sole water source.

2.3.3 Rural environmental sanitation program

In early 1968, the relevant authorities initiated an Environmental Sanitation Survey in 11 selected rural areas in the 11 states of Peninsular Malaysia. The results indicated that only 3.6% of the population was being served with piped water, whereas 85.3% obtained their water from unprotected wells and 11.1% used untreated surface water such as stream and rivers.

Aiming at improving those situations, the Rural Environmental Sanitation Program (RESP) started in 1973 during the Mid-term Review of the Second Malaysia Plan under the responsibility of MOH.

According to RESP, MOH undertakes a water system only after the villages have constructed the pour-flash latrine systems. As the systems aim at providing the basic health and hygiene requirements of the community at the least cost, the systems do not produce treated water and the villagers are advised to boil their drinking water. Basically, the communities provide the labour to construct the systems and they are responsible for operating and maintaining the systems. There is no charge nor tariff for water consumed.

Four types of the water systems are constructed: gravity feed, wells, hydraulic rams systems and rain water catchment tanks:

(1) Gravity feed systems: Basically a small dam or a weir is constructed across a stream and the water is delivered by gravity to the village. The distance from the source to the village varies from less than 1.6 km to about 8 km. Villagers are required to contribute M$20 per household if they want house connections;

(2) Wells: Wells are normally classified as shallow (less than 6 m) and deep (greater than 6 m) wells. The wells are generally lined with 1.2 m diameter concrete rings to the depths of about 6 to 7.5 m. An overhead tank is installed at the well and is connected with the hand pump. After pumped to the tank, water runs by gravity through individual valved lines to the houses. Approximately 3 to 5 houses are served by this type of system;

(3) Hydraulic rams: Hydraulic rams are used to elevate water by using the hydraulic potential of the stream or river. They do not require any further energy input and so they are comparatively cheap to operate. Basically they have not been used very often because they require some topographical situations suitable for this systems; and

(4) Rain water catchment tanks: Rain water catchment tanks are installed only when there is no other alternative. They are found along the coastal line or along contaminated rivers in Sarawak, Kelantan and Kedah. Usually about 2,000 litre (450 gallons) of storage area provided for each household. The water is only intended for drinking and any water required for washing, household sanitation etc. is expected to be obtained from other sources.

The progress of RESP in the States of Sabah and Sarawak from its start in 1973 to 1980 is as shown in Tables 4 and 5. According to this MOH data, the benefitted people who were served water under RESP amounted to 140,500 in Sabah and 327,100 in Sarawak in 1980.

2.3.4 Rural water supply under RESP in Sabah

In the interior and isolated rural areas, the piped water supply depends on the technical and financial assistances of the Medical and Health Services of the Federal MOH under RESP. According to the data provided by the MHS, 146,500 people were being served water through RESP in Sabah as of the end of 1980. The fact indicates that about 18% of the total rural population including suburban rural area is benefitted by RESP. The population who are served water by wells is estimted to amount to 53,900 or 37% of the total population served under RESP if each well is assumed to serve 15 household and the balance of 92,600 (or 63%) is estimated to be served by gravity feed systems as shown in Table 6.

2.3.5 Processing water use in palm oil mill and rubber factory

The processing water required in the palm oil mill and rubber processing factory constitutes the components of industrial water. In a palm oil mill, the raw material, oil palm bunch, is transformed into a crude palm oil after several processing steps in which a high pressured steam is required. The major water requirement in a palm oil mill is for the boiler water to provide the steam.

While, in a rubber processing factory, a rubber latex being tapped from a rubber tree is transformed into a rubber concentrate. Most of the water requirement in a rubber processing factory occurs in this processing.

(1) Palm oil mill

In Sabah, there were 13 major palm oil mills in 1980. Most of them were located in the eastern part of the State comprising the Districts of Tawau, Sandakan, Semporna, Lahad Datu and Labuk/Sugut. These palm oil mills are owned and managed either by SLDB or by private estates.
In general, in Sabah, the palm oil mills are equipped with their own water supply facilities. This comes largely from the requirement that the water for boiler must be secured in its quantity, quality and pressure.
The total production in 1980 was estimated at 938,000 FFB tons.

(2) Rubber processing factory

In Sabah, there were three major rubber processing factories in 1980. They were located in the Districts of Kota Kinabalu, Tawau and Tenom, respectively. The owners of them were Rubber Fund Board (RFB), private estate and the joint venture of RFB and a private estate. The total production in 1980 was estimated at 9,000 DRC tons.

The palm oil mills and rubber processing factories in Sabah are listed with their production capacities in Tables 7 to 11. The location of them is indicated in Fig. 1.

2.4 Water Tariff, Revenue and Expenditure

2.4.1 Water tariff

The water rate in Sabah has been kept at a constant rate of M$2.00/1,000 gallon (= M$0.44/m^3) since 1963. In January 1982, the water rate was raised to M$4.00/1,000 gallon (= M$0.88/m^3). This is the uniform rate and commonly applied to all purposes of water use covering domestic, commercial, industrial and shipping.

2.4.2 Revenue and expenditure

The recurrent revenue and expenditure of the PWD Water Supply Section in 1978 and 1980 are as shown in Table 12. As for the O&M account, the expenditure exceeded the revenue in both the years and the amount of deficit increased from M$2,724 x 10^3 in 1978 to M$5,561 x 10^3 in 1980. The renewal account also showed deficit in 1980. Table 13 indicates the breakdown of recurrent revenue and expenditure of PWD divisional offices; in 1980, in all of the eight Divisional Offices, the expenditure exceeded their billing revenue.

3. PRESENT CONDITION OF D&I WATER SUPPLY AND USE IN THE STATE OF SARAWAK

3.1 Organization

Public water supply in the State of Sarawak is administered by PWD, two statutory bodies of Kuching and Sibu Water Boards. Exceptionally, the Bau District Council provides untreated water from Bau lake to its town people of about 2,400 in 1980.

As a whole, PWD supplies pipe water to urban area excluding Kuching and Sibu. The PWD supply pipeline extends to some suburban rural areas located in the vicinity of urban towns as well. Almost all the water supplied by PWD is fully treated or chrolinated and some are further fluoridated. The water pipelines are connected with individual taps but, in some minor towns, stand pipes are equipped for the common use of near-by households. As of the end of 1980, PWD has 40 water works and other several water supplies for local schools.

The Kuching Water Board supplies water to the whole area of Kuching Municipal Council and its environs as well. The Sibu Water Board supplies water to the whole area of Sibu Municipal Council and its environs as well. These two Water Boards are the statutory bodies and are endowed with the independent accounting functions. The Water Boards provide piped and fully treated water.

As is the case in Sabah, untreated water supply in rural areas is made by the State Government under the technical and financial assistance of the Medical and Health Services (MHS) of the Ministry of Health of the Federal Government. Herein these areas are defined as the MHS rural areas. In MHS rural areas, untreated water supply facilities are constructed by either withdrawing small river water by gravity up to individual house connections or digging shallow wells equipped with hand pumps. As the water is not treated, the users are suggested to boil the water before drinking.

3.2 Urban Water Supply

3.2.1 Urban water supply by PWD and Water Boards

In Sarawak, there are eight cities/towns defined in this Study as shown in Table 1.

Like in the State of Sabah, public water is supplied for all purposes including domestic, industrial, commercial and public purposes and no separate pipeline specified to industrial purposes is installed.

Water Board is peculiar to the State of Sarawak; there is no such agency in Sabah. The Kuching Water Board and Sibu Water Board are providing water to the largest and the second largest towns in Sarawak. In 1980, these two Water Boards supplied daily average water of 70,300 m^3/d which amounted to about 79% of the total urban water supply in Sarawak to the estimated population of 283,400 which amounted to about 77% of the total urban population in Sarawak. The daily per capita consumption in Kuching was estimated to amount to 220 lpcd and that in Sibu 174 lpcd in 1980. The Sibu Water Board depends on river water source, while the Kuching Water Board depends on an impounded reservoir of rainfall storage and river water as well.

The other urban area than Kuching and Sibu are provided water through the PWD water works. In 1980, the daily average water of 18,200 m^3/d was delivered through the PWD water works to the estimated population of 86,200 in total of six cities/towns in Sarawak. The location of six cities/towns is presented in Fig. 2 and their water supply data in 1980 is as shown in Table 14. The estimated daily per capita consumption was estimated to range from 125 to 298 lpcd including all water uses.

The historical water supply data of PWD as a whole including rural water supply is as shown in Table 15 for the period of 1970, 1975 and 1980. PWD water works increased in number from 19 to 40 in the period from 1970 to 1980. The design capacity of PWD water works was expanded from 36,450 to 58,100 m^3/d in the same period with a growth rate of 4.8% per annum, while the water consumption increased from 26,220 m^3/d in 1970 to 33,950 m^3/d with a growth rate of 2.6% per annum.

The Kuching Water Board expanded its design capacity from 23,200 m^3/d in 1970 to 54,300 m^3/d in 1980 with a growth rate of 8.9% per annum, while the water consumption increased from 22,400 to 41,800 m^3/d with a growth rate of 6.4% per annum in the same period.

The Sibu Water Board expanded its design capacity from 15,900 m^3/d in 1970 to 27,300 m^3/d in 1980 with a growth rate of 5.5% per annum, while the water consumption increased from 7,500 to 16,200 m^3/d with a growth rate of 8.0% per annum in the same period.

3.2.2 Water supply in major cities/towns in Sarawak

(1) Kuching

The Kuching Water Board, established in 1959, is responsible for public water supply for the whole area of the Kuching Municipal Council (KMC) and its suburban rural area. There are two water sources for the Kuching Water Board: Batu Kitang intake on the Sarawak (Kiri) river and the Matang intake.

The Batu Kitang intake has two treatment plants with the capacity of 27,300 m^3/d each. The Matang intake is composed of three water sources: the Matang dam reservoir with the catchment area of about 70 km^2, the storage basin of rainfall and the China river source. The rainfall storage basin is used only in the dry period of a few months in the year. Raw water from the three water sources is collected and treated at the Matang treatment plant of which capacity is 9,100 m^3/d.

It is pointed out that the raw water of the Batu Kitang intake is gradually being polluted recently by domestic waste and sewage of people living along the Sarawak (Kiri) river.

In 1980, the raw water of 54,330 m^3/d was withdrawn at the two intakes and the water delivered from the three treatment plants was recorded at 50,780 m^3/d. The water sales were recorded at 41,820 m^3/d excluding the UAF water of 8,960 m^3/d; the UAF ratio was estimated at 18% including the distribution reservoir loss as shown in Table 16. This UAF ratio is comparatively low when compared with the estimated UAF ratio of 30% in Sarawak.

The breakdown of water sales by water use in Kuching is as shown in Table 16. In 1980, the domestic use occupied 47% of the total water delivered followed by the commercial/industrial use of 34%.

The historical water supply data is as shown in Table 17. During the last decade, the water delivered from water works increased at the average annual growth rate of 8.5% and the estimated served population at 5.2% per annum.

(2) Sibu

The Sibu Water Board is responsible for public water supply for the whole area of the Sibu Municipal Council and a part of Sibu Rural District Council including Teku Bazar and both sides of the road running to the Army Camp.

The current capacity of raw water intake and treatment plant consists of the old plant commissioned in 1970 with the design capacity of 9,100 m^3/d and the new plant commissioned in 1979 with the design capacity of 18,200 m^3/d. All the raw water is withdrawn from the head works on the Rajang river.

The breakdown of the water consumption by water use is as shown in Table 19. In 1980, the water delivered from the water works was recorded at 19,500 m^3/d of which the domestic use occupied 52% of the total water delivered, the commercial use 23% and the commercial/industrial use 8%. The UAF ratio was recorded at 17%. The water delivered from the water works increased during the last decade at the rate of 10% per annum. The domestic use, the commercial use and the commercial/industrial use increased at the approximately same rate of about 10% per annum, respectively, as shown in Table 19.

It is noted that the Upper Lanang Industrial Estate is located upper stream of the raw water intake of the Sibu Water Board. The land preparation has been completed for the area of 106 ha in 1979 and the whole area of the industrial estate of 346 ha is scheduled to be completed after 1985. Currently, two factories including a sawmill and a sago refinery are operating already. In the future when the industrial estate starts its full operation, the effluent of the factories discharged into the Rajang river may aggravate the quality of water to be withdrawn at the intake downstream of the industrial estate.

(3) Miri

The Lambir treatment plant commissioned in 1971 has a design capacity of 9,100 m^3/d. The raw water is extracted from the Liku river when it is treated and pumped about 10 km to the Lopeng reservoir. In 1980, the average daily water delivered from the water works was recorded at 8,500 m^3/d. In addition, PWD Miri purchases the treated water of 1,800 m^3/d from Sarawak Shell Berhad. Currently, the water demand regularly exceeds the supply capacity even after the purchase from the Shell and low water pressure is frequently experienced.

It is peculiar to Miri that the Shell oil refinery is located at the coastal area of the town. The Sarawak Shell Berhad has its own water supply system with the capacity of 7,000 m^3/d and provides by itself industrial water required at the oil refinery and domestic water required for its residential staff.

According to the PWD Miri Divisional Office, the breakdown of water consumption in 1980 was informed: 53% of the total consumption for domestic use, 43% for commercial use and 4% for domestic/commercial use.

(4) Bintulu

A rapid regional development of a substantial scale is being under way in Bintulu centering around the Kidurong industrial estate scheme. Although the whole blue print of the industrial development is not finalized yet, the foundation work for a LNG plant and the construction work of the deep sea port are being under way.

The water treatment capacity of the Sibiew water works has expanded from 4,550 to 11,350 m^3/d in 1981. With the rapid development in Bintulu, however, this capacity is anticipated only to meet the water demand at the end of 1982. Accordingly, a new water supply scheme with an additional capacity of 38,600 m^3/d is being undergone using the Sibiew river source.

A new river intake is situated on the Sibiew river about 2 km upstream of the existing intake. The water will be pumped up therefrom to the storage reservoir on the Sika river. This reservoir will be provided by dams with a total crest length of 700 m and a maximum height above the lowest foundation level of 30 m. The storage capacity of the reservoir will be 1.55×10^6 m^3. The new water treatment plant is designed to have the capacity of 38,600 m^3/d. Construction of the new water supply scheme started in February, 1981 and it is expected to be fully commissioned by mid 1983.

3.3 Rural Water Supply

3.3.1 PWD rural water supply

In the rural area in Sarawak, PWD provided water to 34 small towns in 1980. According to the PWD data, the daily average water of 17,000 m^3/d was delivered to the estimated population of 105,400 in 1980. The location of 40 water works is presented in Fig. 2, and the water supply data in 1980 is as shown in Table 14. The daily per capita consumption was estimated at about 154 lpcd.

Most of the water sources are rivers. But impounded rainfall storages constitute the primary water sources in such water works as Lundu, Santubong, Triboh, Simunjan and Lawas. In the delta of the Rajang river, Jerijeh water works have 12 boreholes, the existing sole ground water source in Sarawak, with the yield of 1,350 m^3/d in total and the pipeline extended to Belawai and Rajang areas.

3.3.2 Rural water supply under RESP in Sarawak

Like in Sabah, the piped water supply in the interior and isolated rural areas depends on the technical and financial assistances of the Medical and Health Services of the Federal MOH (MHS) under RESP in Sarawak. According to the data provided by MHS, about 295,000 people were being served water through RESP in Sarawak as of the end of 1980. This indicates that about 31% of the total rural population including suburban rural area is benefitted by RESP. The historical data of the rural water supply under MHS is as shown in Table 6.

3.3.3 Processing water use in palm oil mill and rubber factory

(1) Palm oil mill

In Sarawak, there were four palm oil mills operating in 1980. Compared with those in Sabah, the palm oil mills in Sarawak are small in scale. All of them are located in such coastal área as the Districts of Miri, Mukah and Limbang. Two of them are owned by SLDB, one by a private estate and another one by small holders. The total production in 1980 was estimated at 158,000 FFB tons.

(2) Rubber processing factory

There were five rubber processing factories in Sarawak in 1980. Four of them are located in such coastal area as the Districts of Kuching, Miri, Sarikei and Limbang and one, the biggest in production capacity, is located in the District of Simanggang along the Batang river. The rubber factory located in the District of Kuching is owned by a private estate and all the others are owned by SLDB. The total production capacity in 1980 was estimated at 2,780 DRC tons.

The palm oil mills and rubber processing factories in Sarawak are listed with their production capacities in Tables 20 to 22. The location of them is indicated in Fig. 2.

3.4 Water Tariff, Revenue and Expenditure

3.4.1 Water tariff

The water rates for domestic use in Sarawak effective in 1980 is as shown in Table 23. The water tariff in Sarawak varies by each PWD water work, and the two Water Boards have their own water tariffs. The water rate of PWD water tariffs for one cubic meter of domestic use ranges from M$0.33/m^3 to M$0.38/m^3, while the above water rate of Kuching and Sibu Water Boards is M$0.40/m^3. For industrial use, the Kuching and Sibu Water Boards charge the minimum rate of M$14.25/5,000 gallons; this is equivalent to M$0.62/m^3 which is approximately 1.6 times of the water rate for domestic use.

3.4.2 Recurrent revenue and expenditure

The recurrent revenue and expenditure of PWD Water Supply Section and the two Water Boards are as shown in Table 24. In case of PWD, the deficit increased year by year since 1977 and reached about M$2,200 x 10^3 in 1980 while Kuching and Sibu Water Boards attained surplus every year, though the surplus amounts were in a reasonable range with the rate of return of about 4% to the operating assets in both the Water Boards.

4. WATER SUPPLY EXTENSION PROJECTS IN THE STATES OF SABAH AND SARAWAK DURING 4MP

4.1 4MP Extension Projects in Sabah

In the Fourth Malaysia Plan (1981 to 1985), a number of water supply extension projects are incorporated. Although the final figures will be determined by the Mid-term Review of 4MP to be made in 1983, the presently envisaged framework is described hereunder.

4.1.1 PWD extension projects

According to PWD Sabah, the targets for water supply development in Sabah during the 4MP period are:

(1) An additional 240,000 persons in total of urban and rural to be served with piped water, thereby increasing the service factor from 370,000 persons or 42% to 610,000 persons or 60%;

(2) Out of the above percentage, the service factor of rural area in the State to be increased from 110,000 persons or 18% to 260,000 persons or 39%; and

(3) An additional production capacity of 157,000 m^3/d or 34.5 mgd, thereby increasing the total production capacity from 127,400 m^3/d or 28 mgd to 284,400 m^3/d or 62.5 mgd.

(Some of the above figures representing the present conditions in 1980 are not coincided with those as shown in Table 2. But, as the above targets on the additional population to be served with piped water and those on the additional capacity constitute basic figures of development expenditures for 4MP, those figures remain unchanged.)

In order to achieve the above targets, a number of supply extension projects are envisaged as shown in Table 25. In the 4MP period of 1981 to 1985, the total capital expenditure of M$354.1 x 10^6 is envisaged including that of continuation projects from TMP. The water supply capacity to be newly constructed in the 4MP period amounts to 157,000 m^3/d or 34.5 mgd. Major projects include Kota Kinabalu Water Supply Extension Stage I with a newly added capacity of 54,000 m^3/d or 12 mgd, Sandakan Water Supply Interim Extension Stage I of 18,000 m^3/d or 4 mgd, Labuan Water Supply Extension of 18,000 m^3/d or 4 mgd and Tawau Water Supply Extension Stage I of 20,000 m^3/d or 4.5 mgd.

(1) Kota Kinabalu water supply extension project Stage I
(Continuation project from TMP)

The main components of this project are a new river intake of 54,000 m^3/d or 12 mgd capacity, pumping station, treatment works, 20 miles of 30 inch diameter transmission pipeline, eight service reservoirs, three booster pumping stations and about 100 km of distribution mains of diameters ranging from 6 to 18 inches. This project is scheduled to be completed by the end of 1983 and this production capacity is anticipated to meet the demand until the year 1993. The total capital required during 4MP amounts to M$77 x 10^6; M$52 x 10^6 to be funded by the State and M$25 x 10^6 by Asian Development Bank (ADB).

(2) Sandakan water supply extension project Stage I, interim improvements (Continuation project from TMP)

This project consists of the drilling and construction of 13 additional boreholes and the extension of the existing treatment plant by 18,000 m^3/d or 4 mgd. Out of 13 boreholes, eight boreholes will be completed by April 1981 and be connected with the existing system. This project is anticipated to meet the demand until the end of 1984. The capital cost required during the 4MP period amounts to M$15 x 10^6 which is financed by the State.

(3) Sandakan water supply extension project Stage I (4MP New project)

For the water supply after 1984, a feasibility study has been carried out. Through this study, two priority projects have been selected: the Meliau river project and the Kinabatangan river project. The Meliau river is affluent in discharge but the length of trunk main is long compared with the Kinabatangan project. The Kinabatangan project is informed to have a shortcoming that the water level at the expected intake site fluctuates largely at flood period and that the river course is forced to change by frequent floods. A further study on the Kinabatangan project is being under way and is expected to be completed in 1982. After the completion of this further study, the final decision will be made. For the 4MP budget, the Meliau project was tentatively adopted. In either case, the project is not anticipated to be completed during the 4MP period. This project is anticipated to meet the water demand in Sandakan up to the year 1995.

(4) Labuan water supply extension project (Continuation project from TMP)

This project consists of the construction of 26 boreholes, three impounding reservoirs, treatment works of 18,000 m^3/d or 4 mgd capacity, service reservoirs, trunk mains and distribution mains. A half of the additional capacity is anticipated to be provided for industrial use. The capital cost required during the 4MP period amounts to M$27.5 x 10^6 which is financed by the State.

(5) Tawau water supply extension project, Stage I (Continuation project from TMP)

The main components of this project are the construction of river intake, new treatment works of 20,000 m^3/d or 4.5 mgd, service reservoirs, trunk mains and distribution mains. This project is anticipated to meet the water demand in Tawau until the year 1993. The capital cost required during the 4MP period amounts to M$10 x 10^6; the State fund and the ADB loan will finance M$5 x 10^6 each.

(6) Rural water supply extension projects

The continuation project from TMP of rural water supply extension comprises the extensions and improvements of five existing rural water supply systems for Semporna, Kota Belud, Keningau, Kudat and Kuala Penyu and 14 new rural water supply systems for Kiulu, Apin Apin, Tandek, Tenghilan, Sindumin, Bongawan, Binsulok, Kota Klias, Malabau, Padas Damit, Pitas, Kota Kinabatangan, Banggi and Matunggong.

These projects will provide an adequate piped water to an additional 120,000 rural people. The total capital cost required during the 4MP period amounts to M$27.6 x 10^6 of which M$17.6 x 10^6 is financed by the State fund and M$10 x 10^6 by Federal grant.

The 4MP new projects of rural water supply extension comprise the extensions and improvements of nine existing rural water supply systems for Kunak, Kundasan, Ranau, Tuaran, Papar, Tenom, Kudat, Tamparuli and Tambunan and the construction of seven new rural water supply systems for Kimanis, Merotari Kanan, Tengku, Melalap, Telupid, Kolapis and Mempakul.

The total capital cost required during the 4MP period amounts to M$81.5 x 10^6 of which M$61.5 x 10^6 is financed by the State fund and M$20 x 10^6 by Federal grant.

4.1.2 MHS rural extension projects

During the 4MP period, the MHS Sabah plans to construct 800 water works in rural area; 600 water works by shallow wells and 200 by gravity feed. The additional population of 157,100 will be served water through those water works. The capital cost required for the 4MP period amounts to M$1.5 x 10^6. The breakdown of the new construction works is as shown by Residency in Table 6.

4.2 4MP Extension Projects in Sarawak

4.2.1 PWD extension projects

The total capital cost of M$240.4 x 10^6 is envisaged in 4MP for PWD water supply section including the continuation projects from TMP. Major projects include Bintulu Water Supply Extension with a newly added capacity of 38,600 m^3/d or 8.5 mgd, Miri Water Supply Extension of 18,200 m^3/d or 4mgd. The extension projects of PWD under 4MP are listed in Table 26.

(1) Bintulu water supply extension project
(Continuation project from TMP)

As mentioned in Sub-section 3.2.2, a new extension project with an additional water supply capacity of 38,600 m^3/d or 8.5 mgd is now under way in Bintulu. This project comprises the extension and improvement of existing Bintulu water supply and the construction of new 38,600 m^3/d water supply including the construction of treatment plant, raw water pumping facilities, 1.55 x 10^6 m^3 raw water impounded reservoir, trunk mains and clean water storage reservoirs. The capital cost required for the 4MP period amounts to M$100 x 10^6 which is financed by Federal loan. The construction is scheduled to be completed in mid 1983.

(2) Miri water supply extension project
(4MP new project)

The project components are the expansion of the present treatment plant by 18,200 m^3/d or 4 mgd, the construction of storage and distribution main. The total capital cost is estimated at M$25 x 10^6 and M$7 x 10^6 is allotted under the 4MP from Federal loan.

4.2.2 Kuching Water Board extension projects

The provision for 4MP of Kuching Water Board amounts to M$33.1 x 10^6. The new Batu Kitang Treatment Plant Phase II is the major project with a newly added capacity of 27,300 m^3/d or 6 mgd. About one third of the total fund is allocated to the extension of pipeline networks to rural areas in the environs of the Water Board's supply area.

About 23% of the total fund requirement is to be financed by the own fund of the Kuching Water Board. The breakdown of the extension projects of the Kuching Water Board are listed in Table 26.

4.2.3 Sibu Water Board extension projects

The provision for 4MP of Sibu Water Board amounts to M$9.4 x 10^6. The major project is Sibu water supply expansion Phase II by which the capacity of 18,200 m^3/d or 4 mgd will be newly added. About one third of the fund is allocated to the extension of pipeline networks to rural areas in the environs of the Water Board's supply area. The breakdown of the extension projects of the Sibu Water Board under 4MP are shown in Table 26.

4.2.4 MHS rural extension projects

During the 4MP period, the MHS Sarawak plans to construct 1,250 water works in rural area. The additional population of about 200,000 will be newly served water through these new water works. The capital cost required for the 4MP period amounts to about M$10 x 10^6 as shown in Table 6.

5. PROJECTION OF D&I WATER DEMAND

5.1 General

Water demand was projected in this Study by two categories of water use: domestic water use and industrial water use. The "domestic water" comprises all the water for the purposes of domestic use, commercial use, public use including fire fighting, street cleaning, fountain, government office and other institution uses and other non-industrial uses.
The "industrial" water comprises the water required for the production in manufacturing sector and that required for the processing of palm oil and rubber.

The projection was made first for the consumer's net consumption which was defined in this Study as the "customer demand" (CD) and later it was converted to the water demand at the water source which was defined as the "source demand" (SD) by assuming the treatment plant loss ratio (TP ratio) and the unaccounted-for ratio (UAF ratio) as shown below.

$$SD = CD/(1 - \text{TP Ratio})\ (1 - \text{UAF Ratio})$$

The historical data on the above ratios were not available except for some water works, but based on the information obtained through the field survey, the current UAF ratio was estimated at 40% in average of all the water works in Sabah and at 30% in Sarawak. For the future projection, the TP ratio of 5%, the UAF ratios of 30% in 1985 and 20% thereafter were assumed for Sabah and the UAF ratios of 25% in 1985 and 20% thereafter were assumed for Sarawak in this Study.

No distinction between CD and SD was made for the processing water of palm oil mills and rubber factories. This is due to the fact that these processing water is, in many cases, withdrawn from the water sources near the mills or the factories and the loss or leakage is considered negligible.

The water demand was estimated separately for piped-water demand and for non-piped-water demand. This distinction was required from the planning of water supply facilities to be made in Sectoral Report Vol. 15 "Water Resources Engineering". In urban area, the domestic water was assumed to be served fully through piped water supply and the industrial water was assumed 50% of the total industrial water demand be served through piped-water supply. In rural area, 60% of the total population and 65% of the total population in 1990 in Sabah and Sarawak respectively and 90% of the total population in 2000 in both the States were assumed to be served through piped supply. This assumption was based on the information obtained from MHS. The current ratio of the pipe-served population to the total population in rural area is estimated at 26% in Sabah and 44% in Sarawak.

The water demand was projected for the years of 1985, 1990 and 2000 for each city/town and for each district rural area and was aggregated into each river basin.

5.2 Projection of Domestic Water Demand

5.2.1 Methodology

Domestic water demand was projected first on the basis of customer demand (CD) and was converted into source demand (SD) as mentioned in Section 5.1.

Pipe water demand was projected based on the projected total population, the projected service factor (SF) and the projected per capita daily use (PCDU) by:

Pipe Water Demand = Projected Total Population x SF x PCDU

Non-piped-water demand was projected by:

Non-pipe Water Demand = Projected Total Population
x (1 - SF) x PCDU

5.2.2 Population projection

The population projected for the years of 1985, 1990 and 2000 for 23 districts in Sabah and for 25 districts in Sarawak was prepared in Sectoral Report Vol. 1 "Socio-Economy". The said population projection was made individually by city/town, 11 city/towns in Sabah and eight city/towns in Sarawak, and by each district rural as shown in Tables 27 to 30.

It is noted that, in projecting the population of four city/town including Kota Kinabalu, Labuan, Kuching and Bintulu, the "Greater urban" concept was adopted. This concept was adopted considering that the urbanized area is being expanded remarkably beyond the boundary of the Municipal Council in Kota Kinabalu and Kuching and that the big scale industrialization is being under way in Labuan and Bintulu. Actually, when the future population was projected based on the population living in the current Municipal Council boundary, the growth rate in the period from 1980 to 2000 revealed to be so low as 2.6% per annum in Kota Kinabalu and 1.4% per annum in Kuching. This seems to indicate that the population in these big towns are being saturated.

The population of the greater Kota Kinabalu was projected following a study (Ref. 1) by incorporating its five satellite towns including Menggatal, Inanam, Kasigui, Donggongan and Putatan. The population of the greater Kuching was projected following a study (Ref. 5) by incorporating the northern part of the Sarawak river and the southern fringe area of the Kuching Municipal Council. The population projected in the above study reports was adopted after review as far as possible. The population of the greater Labuan was projected following a study (Ref. 9) by incorporating the Ranca Ranca Peninsular. The population of the greater Bintulu was projected following a study (Ref. 8) by incorporating the Kidurong new town.

It is also noted that, in this Study, the rural population was classified into suburban rural population and isolated rural population. The suburban rural was defined in this study as the rural area that is located in the vicinity of the city/town and to which the water pipeline is being extended from the city/town. While, the isolated rural was defined as the other rural area than the suburban rural. The water demand of the suburban rural area was aggregated into that of the city/town. This distinction was required from facilitating the future planning of water supply capacity to be made in Sectoral Report Vol. 15 "Water Resources Engineering".

The estimated population in suburban rural area in 1980 is as shown in Tables 31 and 32. In the case of Kota Kinabalu, the suburban rural population of about 48,000 was estimated to live outside the greater Kota Kinabalu boundary in 1980; in case of Kuching, the same population was estimated at about 15,000.

The suburban rural population was detached from the total district rural population and projected through 2000 separately based on the growth rate of the rural population of the district in which the suburban rural is situated. The projected population of suburban rural is as shown in Tables 31 and 32.

5.2.3 Projection of service factor

(1) Urban area

The current record of service factor in 1980 was not available in PWD. This is due to the fact that water supply pipeline extends irrelevant to the administrative boundary depending on the facilitation of pipeline extension and on the topographical and geographical conditions. Therefore, in this Study, it was assumed that, when a water work supplied water to the population exceeding its residents inside its city/town boundary, the service factor of the city/town was 100%.

The estimated service factor in 1980 is as shown in Tables 33 and 34. In Sabah in 1980, the service factor of five city/towns were estimated at 100% and that of other six city/towns were estimated to range from 61% to 89%. In Sarawak in 1980, the service factor of four city/towns were estimated at 100% and that of other four city/towns were estimated to range from 59% to 83%.

Based on the estimated service factor in 1980, the future service factor of each city/town was projected by assuming a linear increase through the year 2000 as shown in Table 35. Considering the correlation between the service factor and the per capita GDP, the service factor in 2000 was assumed to vary in Case 1 and in Case 2. In Case 1, the service factor in 2000 was assumed at 100%, while, in Case 2, the service factor in 2000 was assumed at 95% by following the assumption that the GDP projected for Case 2 will be attained delaying by about 5 years compared to the GDP projected for Case 1. The service factor of a city/town of which service factor was 100% in 1980 was assumed to keep 100% through 2000.

(2) Rural area

In 1980, the service factor in the isolated rural area comprising those supplied through PWD and MHS was estimated to amount to 26% in Sabah and 44% in Sarawak as shown in Tables 33 and 34. The service factor in the future for Case 1 was assumed as shown in Table 35 by assuming linear increase from the above estimated service factor in 1980 to that in 2000. The service factor in 2000 was assumed at 90% based on the information obtained from the MHS, Sabah. For Case 2, the service factor in 2000 was assumed at such a level as will be attained in 2000 when the service factor projected in Case 1 will be attained with the delay of 5 years.

The service factor in suburban rural areas was assumed at 100% following the definition of the suburban rural as mentioned in Sub-section 5.2.2.

5.2.4 Projection of per capita daily use (PCDU)

The current data on PCDU were not available during the field survey. Therefore PCDU in 1980 was estimated for each city/town based on the historical water supply data in 1980 provided by PWD and Water Boards. PCDU of each city/town was derived from the total consumption deducted by the estimated manufacturing use thereafter divided by the served population including that in suburban rural area. The manufacturing water use of each city/town in 1980 was estimated based on the gross value of output in manufacturing sector estimated in Sectoral Report Vol. 1 "Socio-Economy". The current PCDU in rural area was assumed as the same as that in the rural area in the Peninsula.

In projecting PCDU in 1990 and 2000, PCDU assumed in the Phase II Study for the Peninsula was reviewed and adopted, which assumed PCDUs depending on the population size of each city/town. In rural area, however, the PCDU was assumed individually for PWD rural and MHS rural based on the estimated current PCDU in each rural area in 1980. PCDU in 1985 was derived from interpolation of those in 1980 and 1990. PCDU for non-pipe-served area was assumed at 40 lpcd through 2000.

PCDU for Case 2 was derived from assuming the 5-year's delay of the attainment of PCDU level assumed for Case 1. The assumed PCDU is as shown in Table 36.

5.2.5 Projection of groundwater use

The projection of groundwater use separately from the surface water use was required from the planning of water supply capacity to be made in the Sectoral Report Vol. 15 "Water Resources Engineering".

In Sabah in 1980, groundwater was utilized for the PWD water supply at four city/towns including Sandakan, Labuan, Semporna and Kota Belud, and at Kuala Penyu in rural area as mentioned in 2.2.1 and 2.3.2. Apart from these PWD water supply, the Medical Services constructed shallow wells in rural areas; about 40% of the total beneficiaries were estimated to depend on groundwater.

While in Sarawak in 1980, groundwater was utilized only at Belawai in rural area as mentioned in Sub-section 3.3.1. The groundwater use through the MHS water works was not known.

In projecting the water demand, the groundwater use was tentatively assumed to be nil in urban area including the above-mentioned four city/towns. The future groundwater use in these four city/towns is individually studied in the planning of water supply capacity.

The groundwater use in rural area is also studied in the above-mentioned planning. The methodology is:

Groundwater Demand = (Share of population served by groundwater to total rural population)

x (Per capita daily use)

Therefore, in this Section, only the share of population served by groundwater to the total pipe-served population in rural area was studied. The derivation procedure is as shown in Tables 37 and 38.

As shown in Tables 37 and 38, about 30% of the pipe-served population was projected to depend on groundwater constantly through the year 2000.

5.2.6 Projected domestic water demand

The projected domestic water demand was aggregated by each river basin as shown in Tables 39 to 136.

Focussing to the customer demand in pipe-served area for Case 1, the projected domestic water demand is briefed as follows.

In the State of Sabah as a whole, the domestic water demand was projected to reach 126.7 x 10^6 m^3/y in 2000 with an average growth rate of 8.8% per annum during the period from 1985 to 2000. The demand in Basin 220 where Kota Kinabalu is located was projected to reach 31.7 x 10^6 m^3/y in 2000 with an average growth rate of 7.0% per annum for 15 years from 1985. The demand in Basin 212 where Sandakan is located was projected to reach 20.5 x 10^6 m^3/y in 2000 with an average growth rate of 9.0% per annum for the same period. The demand in Basin 207 where Tawan is located was projected to reach 13.2 x 10^6 m^3/y in 2000 with an average growth rate of 9.0% per annum for the same period. The total share of these three Basins will amount to 52% of the total domestic water demand of Sabah in 2000.

In the State of Sarawak as a whole, the domestic water demand was projected to reach 145.6 x 10^6 m^3/y in 2000 with an average growth rate of 7.8% per annum during the period from 1985 to 2000. The demand in Basin 246 where Kuching is located was projected to reach 51.2 x 10^6 m^3/y in 2000 with an average growth rate of 6.8% per annum for 15 years from 1985. The demand in Basin 241 where Sibu and Sarikei are located was projected to reach 42.7 x 10^6 m^3/y in 2000 with an average growth rate of 8.6% per annum for the same period. The demand in Basin 231 where Miri is located was projected to reach 15.4 x 10^6 m^3/y with an average growth rate of 10.4%

per annum for the same period. The total share of these three Basins will amount to 75% of the total domestic water demand of Sarawak in 2000.

The domestic water demand projected by each city/town is as shown in Tables 137 to 178.

The domestic water demand in rural area in brokendown by river basin into PWD rural and MHS rural areas and is presented in Tables 179 through 182.

5.3 Projection of Manufacturing Water Demand

5.3.1 Methodology

Industrial water demand was projected in this Study individually for the manufacturing water in the manufacturing sector and for the processing waters of palm oil mills and rubber factories.

The gross value of output by 11 commodity groups in Sabah and Sarawak was projected through 2000 in the Sectoral Report Vol. 1 "Socio-Economy" as shown in Tables 183 and 184. The derivation of manufacturing water demand is shown as follows:

Manufacturing Water Demand = (Gross Value of Output in Manufacturing Sector) x (Water Use per Unit Gross Value of Output)

Since there was no data either on the manufacturing water demand or on the gross value of manufacturing output at any city/town in Sabah and Sarawak, the manufacturing water demand derived from the above was allocated to that in each Residency in Sabah and in each Division in Sarawak according to the gross value of manufacturing output obtained by the Survey of Manufacturing Industries carried out in Sabah and Sarawak in 1974. The shares of each Residency and each Division to the total gross value of manufacturing output in each State are as shown in Table 185.

The manufacturing water demand of each city/town was finally derived from that of each Residency and each Division multiplied by the share of population of each city/town to the total urban population. The direct correlation between the manufacturing water demand and the urban population is not clarified. But it can be said that the urban population will increase accompanied by the employment increase induced by the industrialization, which will bring the increase in manufacturing water demand. In case of the Second Division of Sarawak, since there exists no city/town defined in this Study in this Division, the manufacturing water demand was allocated to each district rural area according to the population share of rural area in which some small towns are located.

The gross value of output to be produced by the new large scale industrial projects including Labuan and Bintulu industrial development projects was estimated individually based on their envisaged production capacity. The estimation of their gross value of outputs is as shown in

Table 186. Since their developments are anticipated by stagewise, these gross value of output was assumed to be realized fully in 1995 for Case 1 and in 2000 for Case 2, respectively (refer to Sectoral Report Vol. 1 "Socio-Economy"). The gross value of output shown in Tables 183 and 184 includes that of the new large scale industrial projects in Labuan and Bintulu.

In projecting the manufacturing water demands for Labuan and Bintulu industrial projects, the cooling water demands for sponge iron, power plant and methanol plant projects in Labuan and for LNG project in Bintulu were assumed to be met by sea water based on the up-to-date information.

5.3.2 Manufacturing water use per unit gross value of manufacturing output

In this Study, the manufacturing water use per unit of gross value of manufacturing output studied in the Phase II Study for Peninsular Malaysia was adopted for the projection of manufacturing water demand. In the said Phase II Study, the historical data in Japan in 1970 was assumed as the manufacturing water requirement per unit of gross value of manufacturing output in Malaysia in 1990 and in 2000 as well. The assumed manufacturing water requirement per unit of gross value of manufacturing output is as shown in Table 187.

5.3.3 Projected manufacturing water demand

The projected manufacturing water demand by each river basin is as shown in Tables 39 to 136.

Focussing to the pipe-served customer demand in Case 1, the projected manufacturing water demand is briefed as follows.

In the State of Sabah as a whole, the manufacturing water demand was projected to increase to 38.7 x 10^6 m^3/y in 2000 with an average growth rate of 10.9% per annum during the period from 1985 to 2000. The demand in Labuan was projected to increase to 10.7 x 10^6 m^3/y in 2000 with an average growth rate of 5.1% per annum for the same period. The demand in Sandakan was projected to increase to 9.7 x 10^6 m^3/y in 2000 with an average growth rate of 16.4% per annum for the same period. The demand in Kota Kinabalu was projected to reach 8.6 x 10^6 m^3/y in 2000 with an average growth rate of 16.2% per annum for the same period. The total share of these three city/towns was estimated to amount 75% of the total manufacturing water demand of Sabah in 2000.

In the State of Sarawak as a whole, the manufacturing water demand in 2000 was projected to increase to 33.4 x 10^6 m^3/y with an average growth rate of 9.3% per annum during the period from 1985 to 2000. The demand in Bintulu was projected to increase to 12.1 x 10^6 m^3/y in 2000 with an average growth rate of 5.9% per annum in the same period. The sole demand in Bintulu was estimated to amount to 36% of the total manufacturing water of Sarawak in 2000.

5.4 Projection of Processing Water Demand in Palm Oil Mills and Rubber Factories

5.4.1 Methodology

The processing schedule of palm oil and rubber was projected for each mill and factory in the Sectoral Report Vol. 5 "Agriculture" as shown in Tables 7 to 11 for Sabah and Tables 20 to 22 for Sarawak. The processing water demand of palm oil and rubber was projected based on this estimated processing schedule multiplied by the estimated unit water use per unit production of palm oil and rubber. The projected demand was counted in that of rural area assuming that all the palm oil mills and rubber factories are situated in rural area for simplification.

5.4.2 Palm oil mill water demand

The processing water demand per unit production of palm oil was estimated at 0.8 m^3 per one ton of fresh fruit bunch (FFB) of oil palm based on the data provided by SLDB.

The projected processing water demand for palm oil mills is as shown in Tables 39 to 136 by each river basin. Focussing to Case 1, the projected processing water demand for palm oil mills is described hereunder.

In the State of Sabah as a whole, the palm oil processing water demand was projected to increase to 1.9×10^6 m^3/y in 2000 with an average growth rate of 2.6% per annum during the period from 1985 to 2000. The total share of Basin 207, Tawau, and Basin 213, Labuk, will amount to 42% of the total palm oil processing water demand in Sabah in 2000.

In the State of Sarawak as a whole, the palm oil processing water demand was projected to increase to 1.9×10^6 m^3/y in 2000 with an average growth rate of 2.6% per annum during the period from 1985 to 2000. The total share of three Basins including Niah, Mukah and Rajang will amount to 54% of the total palm oil processing water demand in Sarawak in 2000.

5.4.3 Rubber factory water demand

The processing water demand per unit production of rubber was estimated at 18 m^3 per one ton of dry rubber concentrate (DRC) based on the data provided by SLDB. Since the processing schedule was made covering only the major factories, it was multiplied by 2.5 in case of Sabah and by 5 in case of Sarawak in deriving the water demand to cover the private small holders scattering around the major rubber factories.

The projected processing water demand for rubber factories is as shown in Tables 39 to 136 by each river basin. Focussing to Case 1, the projected processing water for rubber factories is described hereunder.

In the State of Sabah as a whole, the rubber processing water demand was projected to increase to 1.8 x 10^6 m^3/y in 2000 with an average growth rate of 8.9% per annum during the period from 1985 to 2000. The total share of two Basins including Padas and Tuaran will amount to 67% of the total processing water demand for rubber factories in Sabah in 2000.

In the State of Sarawak as a whole, the rubber processing water demand in 2000 was projected almost the same as in 1980. This is due to the estimated low growth rate of rubber production (1.2% per annum during the period from 1980 to 2000) in Sarawak.

5.5 Projected D&I Water Demand

The projected D&I water demand is summarized in Tables 188 and 189 and depicted in Figs. 4 to 7. When focussed to piped customer demand for Case 1, the projection result is described hereunder.

In Sabah, the D&I water demand was projected to reach 165.4 x 10^6 m^3/y in 2000. The average growth rate was estimated at 9.6% per annum during the period from 1980 to 2000. The average growth rate of domestic water demand was estimated at 9.1% per annum and that of industrial water demand at 11.7% per annum for the same period. The growth rate of D&I water demand was composed of 7.2% per annum of served population growth and 2.2% per annum of per capita daily use growth.

The share of the total D&I water demand in 2000 was estimated at 77% for domestic and 23% for industrial water demand.

In Sarawak, the D&I water demand was projected to reach 181.0 x 10^6 m^3/y in 2000. The average growth rate was estimated at 8.3% per annum during the period from 1980 to 2000. The average growth rate of domestic water demand was estimated at 7.9% per annum and that of industrial water demand at 10.5% per annum for the same period. The growth rate of D&I water demand was composed of 5.8% per annum of served population growth and 2.4% per annum of per capita daily use growth.

The share of the total D&I water demand in 2000 was estimated at 80% for domestic and 20% industrial water demand.

6. PLANNING MATERIAL AND IDENTIFICATION OF PROBLEMS AND NEED

6.1 Planning Materials

6.1.1 Construction cost

Construction cost (investment cost) was estimated in the four categories as follows:

(a) direct construction cost,

(b) engineering service and administration cost,

(c) land acquisition cost, and

(d) physical contingency.

Engineering service and administration cost was assumed at 10% of the direct construction cost. Physical contingency was assumed at 30% of the total of (1) through (3).

Costs of equipments, materials and labor locally available were estimated at 1980 end price level based on the data obtained from PWD and the relevant previous reports.

The costs for internationally traded goods and services were estimated based on the international market price at 1980 end or the World Bank projection up to 1990 where applicable (Ref. 56).

Construction cost for public water supply projects widely varies depending on the topography, geology, land value capacity and size of the facilities and the like. In this Study, however, standardized unit construction cost was assumed for all the projects. The unit cost applied for estimating direct construction cost is shown in Tables 190 and 191.

6.1.2 O&M cost

For PWD water supply, O&M cost (recurrent expenditure) was assumed at 2% of construction cost based on the recurrent expenditure (O&M cost) for water supply recorded by state PWDs and other water supply organizations as well as the corresponding figures in the advanced countries.

Rural water supply systems under RESP (MOH) are operated and maintained by the beneficiaries and O&M cost was assumed nil.

6.1.3 Estimated cost

The estimated investment cost (construction cost) together with the treatment capacity for PWD supply and source demand for RESP (MOH) supply by city/town and rural areas by MP is given in Sectoral Report Public Expenditure and Beneficial and Adverse Effects.

6.1.4 Future manpower requirement for water supply

Manpower requirement in the water supply organizations including State PWDs and Water Boards was estimated for the 1981 - 2000 period. Only the manpower for the management offices and construction offices required for the construction and O&M of water supply facilities proposed in this Study was considered, excluding the staffs at the headquarters.

For 4MP period, manpower requirement for O&M was estimated nil because demand for public water supply up to 1985 would be met by the ongoing water supply projects which are not included in the proposed projects.

The following papers and publications were studied to work out appropriate staffing levels for the O&M and implementation of the proposed projects:

(a) Proposal for New Posts for 1982, Selangor Water Works Department,

(b) Preparatory Paper for 4MP, PWD, and

(c) Comparative Staffing Levels in the Water Works Organization, PWD.

The current staffing levels in the water supply organizations in the advanced countries were also taken into account.

The manpower classification given in Table 192 was adopted in line with the current practice in Malaysia. The formula adopted for O&M (management offices) and construction (construction offices) are given in Table 193.

The estimated manpower required for public water supply in Peninsular Malaysia is given in Sectoral Report Public Expenditure and Beneficial and Adverse Effects.

6.2 Economic Benefit and Cost for D&I Water Supply

6.2.1 Economic construction cost and O&M cost

Economic construction cost (investment cost) for PWD water supply was estimated by deducting the transfer payment from the financial cost. The transfer payment including taxes and local contractors' profit was assumed at 20% of the financial cost.

Unit economic construction cost for rural public water supply through RESP (MOH) was estimated at M$1,580 per m^3/d of supply capacity, taking into account the economic value of the labor provided by the rural inhabitants for the construction. Unit economic construction cost for water supply for palm oil mills and rubber factories was estimated at M$630 per m^3/d of supply capacity by deducting transfer payment from the financial construction cost based on the data obtained from SLDB. That for private water supply for domestic use was assumed at M$90 per m^3/d based on the expenditure on tools and economic cost of labor of the rural inhabitants to fetch water from nearby water sources.

Economic construction cost was estimated based on the unit cost shown in Tables and .

Economic O&M cost was assumed at 2% of the economic construction cost given in the previous section.

6.2.2 Economic benefit

Economic benefit to be derived from water supply including both public and private ones for domestic and industrial uses was estimated by the equivalent economic cost of the least-costly alternative facilities.

For the water source facilities including dams and diversion facilities, various alternatives were planned and the least-costly alternative was selected. In case the source facilities serve for multiple purposes, appropriate cost attributable to D&I water supply was considered as alternative cost. With regard to the rest of the water supply facilities comprising intakes, water mains, treatment and distribution facilities, no alternatives were considered, i.e., least-costly alternative cost is identical with that of the proposed facilities.

6.2.3 Estimated economic benefit and cost

Annual equivalents of economic benefit and cost for D&I water supply at the discount rate of 8% with the study period of 50 years by basin are given in Sectoral Report Public Expenditure and Beneficial and Adverse Effects.

In estimating economic benefit and cost, the water demand in Miri in the State of Sarawak was adjusted by deducting the present water supply capacity of Shell Oil Refinery located in Miri by assuming its supply capacity and PWD's water purchase from Shell will be kept at the present level through 2000.

6.3 Identification of Problems and Need

6.3.1 Local water shortage in Sabah

In some local towns in Sabah, the supply capacity was observed to be insufficient to meet the growing water demand accompanied by the increasing urban population and/or the industrial development. Consequently, water shortage was observed in such towns as Sandakan and Tawau as mentioned in Sub-section 2.2.2, and also in Labuan, Kota Belud, Beaufort and Kuala Penyu. In Sandakan, the water shortage is considered as the biggest constraints of the town among others.

In Labuan where a water rationing has been experienced, the water supply will be one of the key factors for the successful implementation of the on-going large scale industrial development. In Kota Belud, a water rationing of 2 to 3 hr/d in the dry season is being experienced and the expansion of distribution networks is being delayed due to the insufficient capacity of raw water intake. In Beaufort, the supply is being stopped by 2 hr/d due to the insufficient capacity of the distribution reservoir and, though the pipelines have been extended to Kuala Penyu from Beaufort, the water is not conveyed to Kuala Penyu yet.

6.3.2 Drought prone area

In Sarawak, some areas are vulnerable to severe water shortage for one or two months continuously during the drought year. These areas are designated by PWD as the drought prone areas. By and large, the drought prone areas scatters along the coastal low land areas in the First, Second, Fourth, Fifth and Sixth Divisions. In the First and Sixth Divisions, the drought prone area also extend to inland area as well as at the fringes of rural areas of Kuching. Epidemics such as cholera and dysentery have occurred consistently in these areas due to the poor sanitary conditions caused by the extreme dry period of drought.

The major components of the drought prone area are small villages and Kampongs and small coastal towns with the population of about 500 in average with the range from less than 100 to about 3,500 including the surrounding areas. Under normal meteorological conditions, the people in these small villages and Kampongs obtain their water either through shallow wells or from surface water of small streams in the inland area and through rainfall collection in the coastal area. The severe drought period may continue for one or two months during the period of June, July and August, though varying each year. Since these customary water sources depend largely on rainfall during the drought period, the people have no other source to obtain any potable water at all. When such water shortage occurs, the PWD delivers fresh water to the affected area by launches, boats, water tanker owned by PWD, as well as trucks conveying potable water. Sometimes, helicopters were used to carry water tanks to the areas which are inaccessible by roads or river navigation.

The Table 196 shows the number of the drought affected villages in the period from 1972 to 1981 and the population who were served water by PWD transportation in 1981. As shown in the Table, during the late 10 years of 1972 - 1981, it is observed that many villages/areas were struck by severe water shortage in 1972, 1979 and 1981; these are identified as the meteorological drought years in the south-western Sarawak. There were 181 villages/areas severely affected by drought in 1972; 126 villages/areas in 1979 and 227 villages/areas in 1981. Most of them were located in the First Division followed by the Sixth and the Second Divisions.

In 1981 when the drought was estimated to be the hardest in the recent 10 years, the population of about 102,600 or 8% of the total population of Sarawak was affected or struck by drought in one way or another for which relief measures were required. Out of them, the predominant number of about 71,100 were located in the First Division; 13,500 in the Sixth Division and 13,400 in the Second Division respectively.

The drought prone area was delineated into the coastal low land area and the inland area and further classified by the population size of villages into three groups: the village population of less than 500, 500 - 999 and 1,000 and over as shown in Table 197. Out of 102,600 of the total drought affected population in 1981, 75,500 was living in the coastal area and 27,100 was living in the inland area.

The majority was in the First Division: the drought affected population amounted to 71,100 in total of which 45,700 resided in the coastal area comprising the deltaic areas of the Sarawak river, the Samarahan river and the Sadong river. Another 25,400 resided in the inland area. It is observed from the Table that, in the First Division, the affected villages were comparatively big Kampongs with the population of 500 and more in the coastal area; among them, nine Kampongs had the population of 1,000 and more. While in the inland area, more than half of the affected villages were those small Kampongs with the population of less than 500. In the Second and the Sixth Divisions, the majority of the affected Kampongs was located in the coastal area and most of them were those big villages with the population of 1,000 and over.

Considering the significance of severe water shortage in this drought prone area, the PWD Sarawak is undertaking the construction of water supply facilities in several of these areas under 4MP. Four pilot projects of rain harvesting are under design by PWD; these projects aim at storing rain water during the rainy season in sizable metal tanks which have the capacity to provide the villages with potable water for the period of the severe drought.

It is to be noted that the data referred above on drought struck Kampongs and villages are no means complete. There are many other smaller Kampongs and villages at and near the coastal regions which are affected by drought. But to date, they have not made or able to make specific requests for assistance since their areas are so scattered and inaccessible for transport by boat or roads.

In the interior rural area in Sarawak, especially in fishermen's villages located along the west coast, the villagers were informed to be suffered from water shortage.

6.3.3 Amendment of water tariff

As mentioned in Sub-section 3.4.2, the financial record of PWD indicates a substantial deficit in both Sabah and Sarawak. One of the causes of this deficit is the current comparatively low water rate. The present water tariff has been kept unchanged since more than 10 years ago. The percentage share of the water charge to the total household expenditure was 1.0% in Sabah and 1.1% in Sarawak in 1973 as shown in Table 198. Since it is anticipated that the growth of household expenditure has been exceeding that of household water consumption, the said share is presumably lowered at present than that in 1973. Therefore, the higher water rate is deemed to be payable by consumers. An appropriate water rate is deemed desirable from the point of view of viable management of water supply and of prevention of water waste by consumers.

While, in case of Water Boards, the financial deficit is also anticipated in the near future though both the Water Boards is currently generating some surplus. The Kuching Water Board has already completed the study on the amendment of its water tariff (Ref. 7).

An observation on the existing water tariffs in Sabah and Sarawak is compiled in Chapter 7 in this Report.

6.3.4 Manpower shortage

The shortage of manpower for construction and management of water supply facilities was widely observed throughout the State of Sabah and Sarawak in every field including planning, investigation, design, construction supervision and operation and maintenance. In case of PWD Sabah, about 90% of the development budget was informed to have been entrusted to consultants and contractors these years. Even in this case, the supervision works will have to be done by the PWD staff. Since new development projects are anticipated to increase in the near future, the PWD staff will be required to be reinforced for a smooth implementation of extension works and for a smooth operation and maintenance of water works as well. The shortage of the skilled manpower was pointed out as one of the constraints in the Kuching Water Board as well.

7. OBSERVATION ON WATER TARIFF

7.1 General Comments on Existing Water Tariff

7.1.1 Existing water tariff

In Sabah, as stated in Sub-section 2.4.1, the water rate was amended in January, 1982 and the uniform rate of M$4.00/1,000 gallon was set for all purposes of water uses throughout the State.

While in Sarawak, the water rate varies by each water authority and those of Water Boards are set independently from the water rate of PWD. Some typical schedules of water rate are shown in Table 199. Most of the water authorities have only single schedule of water rate to be applied commonly for all purposes of water use. But the large scale water authority such as Miri and the Kuching and Sibu Water Boards have the water rates which differ by the purpose of water use: domestic, domestic/commercial and commercial.

7.1.2 General comment on existing water tariff

In case of Sabah, the uniform water rate makes it easier and more efficient to collect water charge than in other State. The incentive for saving water may be strong because there is no minimum charge and all the water charges are computed proportionally based on the water consumption.

On the other hand, the burden of water charge may become heavier to the low income consumers than in other water rate schedules because the uniform water rate has no consideration to the capacity to pay of the consumers. The life line water requirement to meet basic sanitation needs is desirably discriminated and the water charge thereof is desirably as low as possible.

In case of Sarawak, the monthly water charges for domestic use are computed as shown in Table 200 based on the existing water rate schedule of the typical water authorities and of the Kuching and Sibu Water Boards. As shown in the Table, all the water rate schedules except that of Sri Aman have the provision of minimum charge which constitutes the water rate for the minimum water consumption. The minimum water consumption varies by water authority and ranges between 2,000 gal/month (9.1 m^3/month) to 4,000 gal/month (18.2 m^3/month); Sri Aman has the uniform water rate of M$1.5/1,000 gal. without any minimum charge. As the consumption increases, the total amount of water charges increase but within the range of minimum charge consumption, the unit water charge per 1,000 gallons which is presented in parentheses in the Table decreases as the water consumption increases. In many water authorities, the unit water charge per 1,000 gallons at the consumption level exceeding minimum water charge consumption is set at the same rate as that at the ceiling consumption level of the minimum water charge consumption.

The exceptions are the Marudi Water Authority and the Water Boards. In case of Marudi, the unit water charge per 1,000 gallons decreases when the consumption exceeds the ceiling of minimum charge consumption. While in case of Water Boards, the unit water charge per 1,000 gallons, though slightly, increases when the consumption exceeds the ceiling of minimum charge consumption.

In order to examine the disparity in the water rates among Water Authorities and Water Boards, the ratio of the maximum water rate to the minimum water rate was computed as shown at the bottom line of the Table 200. The said ratios decrease as the consumption increases from 2.80 at the consumption level of 2,000 gal/month to 1.48 at the consumption level of 5,000 gal/month. The Miri Water Authority has the minimum water charge throughout all the consumption levels. While, the Marudi and Kapit Water Authorities have the maximum water charges at the low consumption level of 2,000 - 3,000 gal/month and the Water Boards have the maximum water charges at the high consumption level of 4,000 - 5,000 gal/month.

From the above observations, the followings may be commented:

(1) The minimum charge consumption level is recommendable to be commonly set at that of the present minimum of 2,000 gal/month. At present, the minimum charge consumption level varies by Water Authorities and by Water Boards and ranges between 2,000 and 4,000 gal/month. In case of the minimum charge of 4,000 gal/month, the low income people whose consumption may be far less than 4,000 gal/month must pay the water charge for 4,000 gal/month and this may bring unfair burden to the low income group;

(2) The disparity among the water rates that is shown by the ratio of maximum water charge to the minimum water charge should desirably be smaller in the low water consumption level than in the high water consumption level. The fact is, as the Table shows, this disparity lessens as water consumption increases. Since the conditions of water supply vary by each Water Authority and Water Boards, the water charge may accordingly vary. But, such a diversification in water supply conditions should be reflected at the high consumption level and, from the point of view of civil minimum, the water rates are desirably equal at the life level consumption; and

(3) The water rate of the Miri Water Authority should be adjusted taking into consideration the water rates of other Water Authorities and Water Boards. At present, Miri enjoys the lowest water rate and this is partly brought by the cheap water supplied through Sarawak Shell Berhad. At least, the minimum water charge should be set at the same level as those of other Water Authorities and Water Boards.

The water rates for domestic/commercial and for commercial in Sarawak are scheduled for the Miri Water Authority and the Water Boards and are as shown in Table 199. The water charges by consumption level are also shown in Table 201. When the unit water rates per 1,000 gallons are compared among water uses, it is found that the water rate increases in the order of domestic, domestic/commercial and commercial. This seems to reflect rightly the capacity to pay of the consumers of each water use.

The minimum charges are set for the minimum water consumption of 5,000 gal/month for both the Miri and Water Boards and for both the domestic/commercial and commercial; this seems to be reasonable.

For both domestic/commercial and commercial water uses, the unit water rates per 1,000 gallons decrease as the water consumption increases. This may bring an adverse effect to water saving. Since the fixed cost such as pipeline installment for big consumers is higher than that for small consumers, the water rates for big consumers should, if the minimum charge is common to all consumers, be set at a higher level than small consumers.

7.1.3 Collection of water charge

How to improve the efficiency in collecting water charge is a problem to every agents of public water supply. A case of the Tokyo Metropolitan Bureau of Water Supply is described below.

Before 1971, the Water Bureau carried out meter reading and sent a bill of water charge to each household once in every two months. Since 1972, however, considering the hike in personnel cost related to charge collection, meter reading has been carried out once in every six months. The water charge is settled totally in every six months by billing every two months an approximate water charge which is estimated in advance based on the household's consumption in the preceding six months.

For big consumers such as factories, however, as their charges are big amounts, meter reading as well as billing water charge is carried out every month. By the same reason, meter reading and billing water charge for medium scale consumers such as laundries and food processing manufacturers are carried out every two months.

Preparation of the water charge bills is carried out through electronic computer. Payment of the bills by customers is made through any banks or post offices located nearest to customers or through automatic withdrawals from customers' deposit accounts in any banks.

7.2 Principles for Water Rate Scheduling

7.2.1 General principles for water rate scheduling

The general principles to be taken into consideration in scheduling water rates are described as follows:

(1) Scheduling of water rates should be based on whole cost accrued from serving water to consumers;

(2) The whole cost will include operating cost and capital cost. The whole cost should cover not only the existing operation and maintenance cost but the cost required for future reinforcement of facilities;

(3) Water rate revenue should cover the whole cost; and

(4) Water rate should be scheduled based on individual cost accrued from serving water to individual consumers. This is required from the point of view of equity in sharing the cost.

7.2.2 Guideline for water rate scheduling

The way of scheduling water rate diversifies among countries and also diversifies even in a country. Conditions of water supply such as topographical ones, water availability and some considerations in political and social aspects are the major causes of such diversifications in water rate schedules.

A study on water rate scheduling was carried out by the Japan Institute of Water Supply in 1979 (Ref. 21). This is the most up-to-date study on water rate scheduling in Japan and is deemed to be one of the most advanced ones in the world. Based on the result of this study, the guideline for water rate scheduling is described hereunder.

(1) Individual costing

In order to secure the equity among consumers, water rate should be scheduled on the basis of individual costs required in serving water to each consumer through water works. The individual costing is a prerequisite to the pipeline-size group rating to be stated in the following paragraph. The basic principle of individual costing is, when stated relevantly to the pipeline-size group rating, to allocate the whole cost to individual customer groups on the basis of their pipeline-sizes which are considered to properly represent the fixed cost required for individual customer groups. This principle reflects the fact that supply facilities including distribution pipeline are designed according to the daily maximum demand of individual customers.

The whole cost is brokendown into customer cost, fixed cost and variable cost. The customer cost includes such costs as meter installation, meter reading, water charge collection and it increases proportionally as the customers increase. The fixed cost is composed of capital cost and operating cost excluding the customer cost. It is the cost required to maintain and to expand water supply facilities and is required independently from production level of water supply. The variable cost includes such costs as additives, electric power and other costs and increases nearly proportionally as water production increases.

(2) Objective period for scheduling

Taking into considerations the desirability for stability of water rate and the reliability for estimating the future expansion cost, three to five years are reasonable as the objective period for scheduling water rate. The future expansion planned during this period should be considered in scheduling the water rate.

(3) Classification of customers

Customers should be classified into a number of groups based on their sizes of distribution pipeline. The alternatives will include the classification based on water uses such as domestic, commercial and industry. But this has a shortcoming that the objective classification by water use is difficult and the boundary of classification is apt to be obscure. The classification of customers by size of distribution pipeline can be made objectively.

(4) Minimum charge

The minimum charge should be set individually by pipeline size of individual customers. (The minimum charge consumption of 10 m^3/month, for example, may be appropriate for a pipeline size of less than 25 mm.) This can be made only when the aforementioned individual costing system is established. The underlying principle is that individual customers should pay according to their individual fixed costs. But, as the fixed cost occupies a large portion of the whole cost, the minimum charge will amount so large if all the fixed cost is allocated to the minimum charge. Therefore, it is to be admitted to allocate to the minimum charge only the customer cost or the sum of customer cost plus a portion of fixed cost.

(5) Meter charge

Fixed cost excluding customer cost and all the variable costs are to be allocated to meter charge. The meter charge should be set at a uniform rate and be applied commonly to all the customer groups which are classified by the size of distribution pipeline. But when it is required to suppress or to promote water consumption, the meter charge is to be set increasingly or decreasingly as the consumption increases.

7.3 Sample of Water Rate Schedule of Tokyo Metropolitan Bureau of Water Supply

A typical sample of water rate schedule based on pipeline-size group is taken up from that of Tokyo Metropolitan Bureau of Water Supply as shown in Table 202. All the customers are classified into four groups according to pipeline size of customers: groups with pipeline sizes of 13-25 mm, 30-40 mm, 50-75 mm and 100-300 mm. The minimum charge is set individually for each pipeline-size and it ranges from 410 Yen/month for pipeline-size of 13 mm and 420,000 Yen/month for pipeline-size of 300 mm.

The meter rate is set for each four customer group according to one to five ranges of consumption level which varies by each customer group. For example, for the customer group with the pipeline-size of 13-25 mm which covers most of the domestic customers and some of the small scale factories and commercial customers, the meter rates are set at 80 Yen/m^3 for the consumption of 11-20 m^3/month, 100 Yen/m^3 for 21-30 m^3/month, 120 Yen/m^3 for 31-100 m^3/month, 170 Yen/m^3 for 101-200 m^3/month, 210 Yen/m^3 for 201-1,000 m^3/month and 250 Yen/m^3 for 1,001 m^3/month and over. The meter rate for consumption of less than 11 m^3/month is nill and is covered by minimum charge.

A modification to the guideline mentioned in 7.2.2 is seen in the differential meter rate which varies by the consumption level. This is scheduled mainly aiming at lessening water charge for customers with low consumption level, stimulating water saving motivation and also charging high marginal cost of water source development to large consumers.

7.4 Water Rate for Industrial Use in Sarawak

7.4.1 Existing water rate for industrial use in Sarawak

In Sarawak, the water rate for industrial use is mainly scheduled in "Commercial" use. As stated in 7.1.2, the water rate for commercial use is set at a higher level than that for domestic and domestic/commercial. This can be said to be reasonable when the capacity to pay of customers is considered. As shown in Table 200, the unit water charge per 1,000 gallons for both the Miri Water Authority and the Water Boards slightly decreases as the consumption increases. This brings though slightly an adverse effect for water saving.

7.4.2 Comments on existing water rate for industrial water use in Sarawak

The ratios of water rate for commercial use to that for domestic use are computed at 1.76 for the Miri Water Authority and 1.95 for the Water Boards on the basis of the equal consumption of 5,000 gal/month. It is hard to determine theoretically what differential ratio is appropriate. However, the water rate schedule based on pipeline-size group mentioned in 7.2.2 would automatically solve this problem because the pipeline-size group water rate schedule does not require to classify customers by their water uses.

7.4.3 Industrial water supply networks

In this Study throughout the whole Malaysia including the Peninsula, all the industrial water is assumed to be supplied through the same pipeline networks as domestic water without installing any water supply system specified to industrial water supply. This is based on the following reasons:

(1) Dual pipeline system with separate pipelines for domestic and industrial uses costs more than single one; this is caused by the fact that treatment cost is marginal for industrial water as the treatment is done in bulk of water while the cost of a factory pipeline would be doubled by installing dual pipeline for both the treated water for factory workers and the non-treated water for industrial purpose; and

(2) In case of Malaysia, there is and will be in the near future, no such a big industrial water demand for one complex that an industrial water supply system with an independent intake through in-complex distribution network can pay the whole cost of the industrial water supply system.

In Japan, there are 164 industrial water supply systems operating as of 1975. The supply capacity ranges from 1,860 m^3/d to 416,800 m^3/d with an average capacity of 91,700 m^3/d.

Quality of industrial water is not standardized by government regulation. The quality of effluent from factory is regulated by law. A standard of quality of industrial water, however, is shown hereunder which is compiled by the Japan Institute of Industrial Water Supply (JIIWS) based on the existing data on industrial water quality of the presently operating industrial water works.

Standard Quality of Industrial Water

Item	Unit	Value	Remarks
Turbidity	degree	20	
pH	-logH	6.5-8.0	
Alkalinity	mg/lit	75	$CaCo_3$
Hardness	mg/lit	120	$CaCo_3$
Evaporation Residue	mg/lit	250	
Chlorine Ion	mg/lit	80	
Iron	mg/lit	0.3	
Manganese	mt/lit	0.2	

There is no standard in terms of BOD. According to the regulation standard on river water quality to preserve living environment, however, the river water with BOD of less than 10 mg/lit is presented to be suitable for industrial water use, if it is treated through an appropriate messures. Therefore, the river water with BOD of less than 10 mg/lit can be considered as the minimum standard required for industrial water use.

Actually in Japan, many industrial water works are equipped only with sedimentation basin without any chemical additives.

In Japan, water rate for industrial use is cheaper than that for domestic use; according to a data compiled by JIIWS (Ref. 22), the industrial water rate was 11.74 Yen/m^3 (= M$0.55/1,000 gal) in 1975 while the domestic water rate was 66.70 Yen/m^3 (= M$3.12/1,000 gal). This was due to the government's subsidy for construction of industrial water works; according to the same data, the government's subsidy amounted to 25% of the total capital investment required for construction of industrial water works accumulated up to 1975.

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