別添資料2

# WATER SUPPLY AND ENVIRONMENTAL SANITATION IN JAPAN


Mr. Shigeru SUZUKI
Dr. Shoichi KUNIKANE
Mr. Hiroyuki ISHITOBI
Dr. Yoshitaka MATSUO
Mr. Takao WATANABE





COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR
Jakarta, 27 – 28 February 1989


JICA

# WATER SUPPLY AND ENVIRONMENTAL SANITATION IN JAPAN



Mr. Shigeru SUZUKI
Dr. Shoichi KUNIKANE
Mr. Hiroyuki ISHITOBI
Dr. Yoshitaka MATSUO
Mr. Takao WATANABE

COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR
Jakarta, 27 – 28 February 1989

# WATER SUPPLY AND SANITATION ADMINISTRATION IN JAPAN

Mr. Shigeru SUZUKI

Director, Office of Regional Planning,
Water Supply and Environmental Sanitation Department,
Ministry of Health and Welfare
Government of Japan

COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR
Jakarta, 27 - 28 February 1989

SEMINAR ON WATER SUPPLY
AND SANITATION
27~29 Feb. 1989
JAKARTA , INDONESIA

# WATER SUPPLY AND SANITATION ADMINISTRATION IN JAPAN

Shigeru SUZUKI
Office of Regional Planning
for Waste Disposal,
Ministry of Health & Welfare
Japanese Government

TABLE OF CONTENTS

6. SUPPLEMENTAL MATERIAL
WATERWORKS IN JAPAN (1988)
Water Supply and Environmental Sanitation Department,
Ministry of Health and Welfare
Japan International Cooperation Agency
Japan Water Works Association

7. SUPPLEMENTAL MATERIAL
ENVIRONMENTAL SANITATION IN JAPAN (1988)
Abstruct of "SOLID WASTE MANAGEMENT IN JAPAN (1988)"
Ministry of Health and Welfare
Japan Waste Management Association,
Japan Environmental Sanitation Association,
Japan International Association of Environmental Sanitation

## I . An introduction of Japan

A breaf introduction of Japan is given for well-understanding of the background of water supply and sanitation in Japan.

### 1.1 Geographic aspects

Fig-1 shows the map of Japan.Japan is an island nation of Japanese archipelago extended 3,000km in Western Pacific. It is located in the temperate zone with four seasons and divided into Pacific Ocean side and Japan Sea side with low population density levels by central rugged mountain ranges.

Due to these geographic features , Japanese river , especially originated in central mountain ranges , are short and fast running into the coastal marine zones. And they have large variations in water quantity depending on seasons.

Table-1 shows some basic data of Japan. There is about 380,000 km² area of Japanese territory,corresponding to 0.2 of Indonesia territory. Only 1/4 is flat and almost all part of the rest , namely 2/3 of the whole area is covered by forest.

### 1.2 Industrial aspects

Originally ,in Japan , main industry was agriculture, forestry and fishery, and manufacturing industry was done in small scall. However,industrial structure has been changed in the past half century , particularly rapidly around the 1960's. Agriculture ,forestry and fishery have been declined . New trend of structural changes in industry have observed after the oil shock in 1973. Particularly, energy and raw material exhaustive industries have been gradually shifted to new advanced technology industries.

Those structural changes in industry have generated the important environmental consequences through not only wastes but also products.

### 1.3 Population

There were 121.5 million of population in 1986. Nearly 60 % of them live in only 2.7% of territorial space. More than half of whole workforce of 58.1 million are employed in commerce and services. One-forth have jobs in manufactur -ing and the percentage of workforce in agriculture and fishery is only less than 10 %.

Aged population over 65 years old shares 9.6% of the total population. Rapid aging population is the most important social and economic problem at present and in future through the reduction of workforce,the expense for welfare and so on.

Population ,GNP and energy consumption loads per km² of habitable land are extremely high compared to other industrialized nations.

### 1.4 Governmental organization

Japanese governmental organization is of three individual parts ; legislative organization,executive organization and judicial organization . In the executive

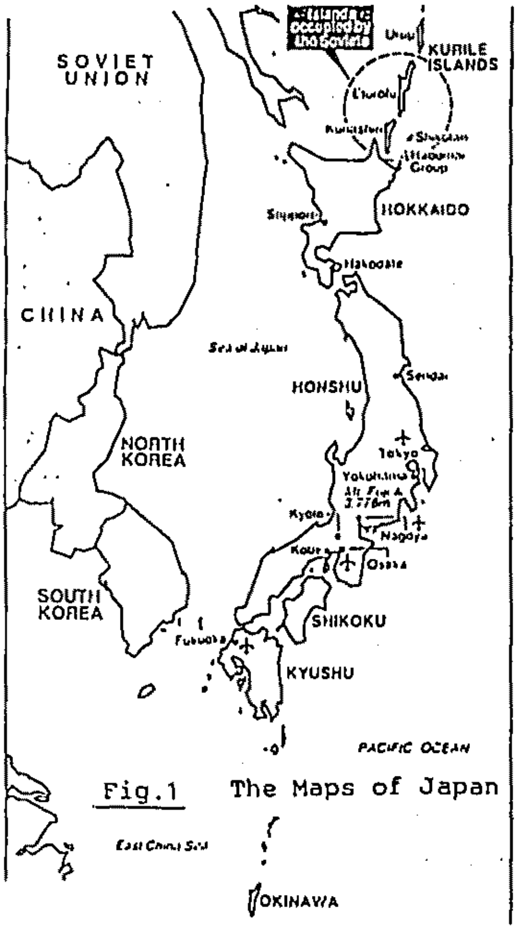



Fig.1 The Maps of Japan

Table 1 Some Basic Data of Japan

| Item | | Japan |
|---|---|---|
| Area | Size ($10^3 km^2$) | 377.8 |
| | % cultivated | 12.6 |
| | % forest | 66.7 |
| | % pasture | 1.6 |
| Population | Size (million) in 1986 | 121.5 |
| | Projected year 2000 | 128.1 |
| | Years till population doubles | 107 |
| | Urban pop. as % total | 76 |
| Workforce | Total (million) | 58.1 |
| | % commerce and services | 53.1 |
| | % manufacturing | 25 |
| | % agric. and fishing | 8.5 |
| | % construction | 9.1 |
| | % govt. and public authorities | 3.4 |
| Production | GNP bns in 1985 (US$) | 1,349.7 |
| | Per capita income in 1985 (US$) | 8,316 |
| | Agriculture as %GNP | 3.2 |
| | Industry as %GNP | 93.2 |

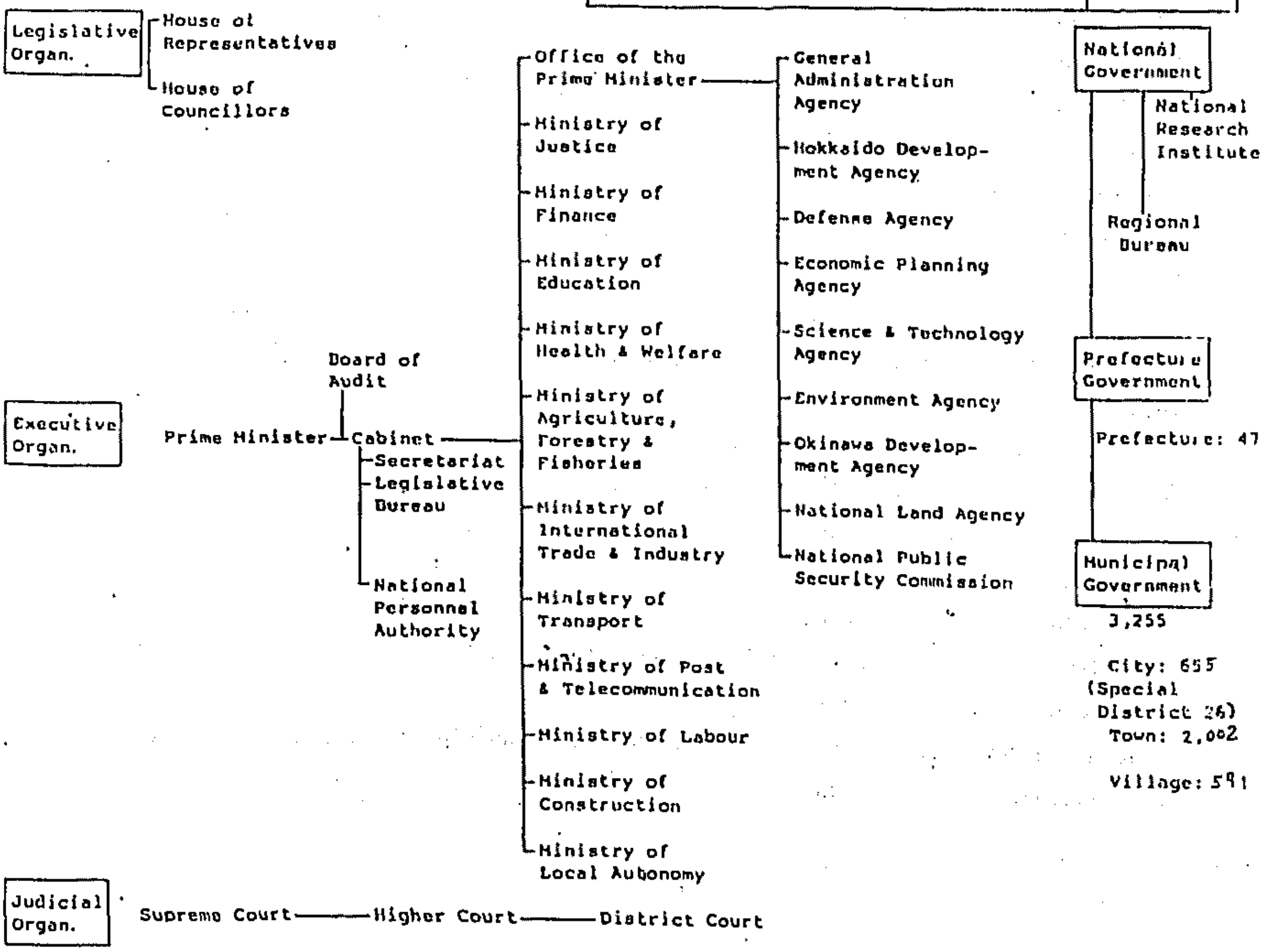



Fig.2 Governmental Organization in Japan

organization , there are 12 ministries including Office of Prime Minister, being composed of 9 agencies , as shown in Fig-2.

## 2. Water supply administration in Japan

### 2.1 History of water supply in Japan

The histry of water supply in Japan remains in the orbit of urbanization.

Tokyo was opened as Edo in 1590 and the population of Edo reached more than one million in 17 century. The government constructed five water supply systems to meet water demands,in which Tama water supply system had river water intake and 40km length of water channel and distribution facilities of wood and stone (no purification process).

Japan's trade with foreign countries became increasingly active since mid-19th century. On the other hand , there were nation wide (especially in harbour cities) epidemics of cholera and typhoid fever. As a result , such harbour cities realized earlier than big cities the necessity of providing a wholesome water supply. The first modern water supply system in Japan was completed with cast iron pipes , pumps , and slow sand filters in Yokohama in 1887 . After trainned for a few years Japanese engineers designed and constructed water supply systems in many cities(particularly in port cities).

At these early stages of Japan's modern water supply history , there were notable activities by foreign engineers. Among them , H.S Palmer and W.K.Burton both from British water engineers , were well known. They played active parts in Japan as consultants to the Government and gave lectures in the universities.

In 1890 The Water Works Ordinance was promulgated, which had the principle that only municipalities could make public water supply systems. This public-owened service principle was amended later , main stream of water undertakings has been created by cities , towns and villages.

With progress of the Japanese Industrial Revolution during the end of the 19th Century and the beginning of the 20th Century,materials for water supply systems gradually changed to become Japanese domestic products. By the end of the 1920's many of them were already being made in Japan.

The Water Supply Committee, started as a voluntary organization of water works in 1904 ,was reorganized into the Water Works Association in 1931 and dealt with the checking of iron pipes after 1935. In 1904,the Water Supply Committee issued standard method of water examination as their first project,and it was revised several times afterwards by the Water Works Association.

During World War II many facilities were damaged , after the War water undertakings were heavily engaged with repair works even under the shortage of materials.

As time passed ,it becomes nessesary to conform the legislation to meet the needs of new situations along with the dedelopment of water works.

The necessity for strong central administration in the water industry had been realized by some people before World War II. However , administration divided between two ministries , prevented the establishment of a comprehensive water works law. After World War II several bills were proposed by each ministry , but it was not until 1957 that the Ministry Health and Welfare was chosen as the competent Ministry and the Water works Law was passed. (See Fig-3)

Thereafter water supply in Japan entered the new stage of enlargement of supplied people. It should be noted that water supply services in rural areas around a small/middel city as small water supply system was subsidized since1953 by the Government stimulating people's awareness for improving living condition , and these facilities created the citizen's interests for water supply.

With the increase of water demand caused by the rapid economic growth after the later 1950's, the necessity of the development of water resources was widely appreciated. Many plans for dams were launched and the water resources development especially in 5 designated big river systems related to large cities.
At the same time water pollution in rivers and lakes also increased ,which led the Laws concerning environmental pollution and establishment of Environment Egency in 1971.

Using the governmental subsidy system established in 1967 for water resources development , many new works and extention projects have been coping with the increase in water demand.

Many problems caused by scattered and small water works were also realized in early 1960's . The Environmental Advisory Committee was founded in the Ministry of Health and Welfare in 1965 and the Minister questioned " a way of regrouping water works " . Reflecting the opinion of Committee, a govern-mental subsidy system for regional wide water suplly system was introduced in 1967. Nearly 70 bulk water supply systems were established after 1967. However , advanced regrouping was necessary to rationalize water supply further. The Water Works Law was amended in 1977 and a regional plan for water supply by the regrouping of water undertakings was to be the responsbility of 47 Prefectural Governments.

Today , the responsibility of water works to supply wholesome water is increasing more and more , because people cannot be without reliable water , not only in human life but also in collective social activities.

A great deal of consideration to the improvement of water supply systems and to coping with the needs of the 21st Century was given in 1984 by Advisory Committee of Living Environment in the Ministry of Health and Welfare , a report titled " Policies for water services for the future " was submitted.

## 2.2 Legislation and Organization on water supply administration

### 1) Legislation

The basic law concerning water supply is " Water Works Law ", and many laws concerning water supply facilities and services exist because it has many aspects. Figure-4 shows laws concerned with each aspect from construction to operation. The Water Works Law was established in 1957 succeeding to the Water Works Ordinance of 1890 and it was amended in 1977 to meet present conditions.

The purpose of the Law is to supply clean and rich but cheap water by securing reasonable and rational construction and management of water system , as well as to construct and manage water supply system intentionally , and protecting and fostering water works and thereby contributing to the improvement of public health and betterment of living environment.

In short the Law are----

(a) categorizes water works as follows ;

" Large water supply "is the system where the planned population served is more than 5,000 .

" Small water supply "is the system where the planned population served is between 101 and 5,000. This system is sometimes called rural water supply system.

" Private water supply "is the system where the population served is more than 100 for private use such as dormitry, company-owned apar-tment houses.

" Bulk water supply " is the water supply system which supplies potable water to large/small water supply systems.

" Small Private Water Supply System " is the water supply system in buildings which facilitates a receiving water tank of capacity of more than 10$m^3$ and receives potable water from large / small water supply. (Number of systems 101,324)

(b) prescribes that requested by local public entities , government of prefecture shall establish a long-term regional plan about waterworks within acertain area,

(c) establishment water quality standard and design criteria which every water works is subject to,

(d) prescribes that in priciple , local public entities shall manage public waterworks and bulk water supply systems , and that when they establish them and modify their plans, their facility and management plannings must be approved either by the Minister for Health and Welfare as to large scall ones or by a governor of prefecture as to small ones , and ,

(e) obligates each public waterworks, bulk water works and private water works manager to have a technical manager , under whose supervision the facilities and water quality must be properly managed and maintained.

2) Organization and Responsibility

・The Ministry of Health and Welfare is the central administrative organizatio

-n for water supply. It does not manage water works directly, but regulates and guides water works in technical and financial aspects on basis of Water Works Law. ( Fig -5-1,5-2, 6 )

In the Government, many ministries and agencies are concerned with water supply on the management of rivers , pollution control of the environment and support of finance. Fig-6 shows the main concerned Ministries and their respective roles

・Japan is divided into 47 prefectures. Local Government of each prefecture has supervisory roles etc. for water supply undertakings under the guidance and instructions of the Ministry of Health and Welfare, in which some of the prefectures have bulk water supply systems for municipalities and few are supplying water for inhabitants directly.

・Local authorities of cities , towns and villages are main water undertakings in Japan. They are supplying water for people in their respective areas either by individual authority or by joint authority.

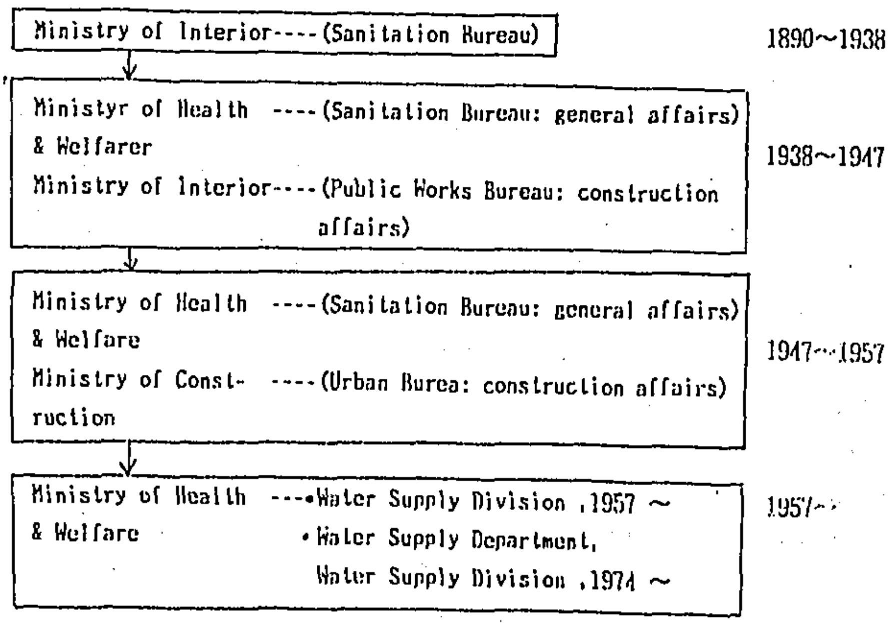



Fig- 3 Trend of competent authorities on water supply works

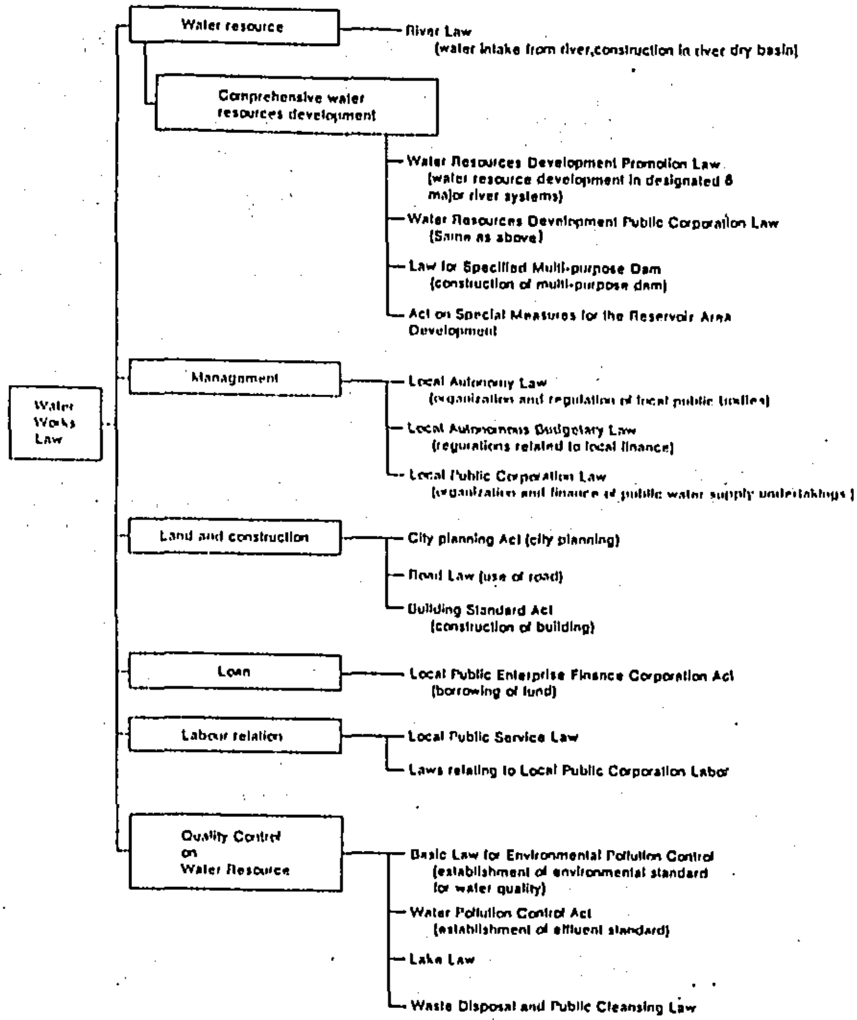



Figure-4 Legislation Concerning Water Supply

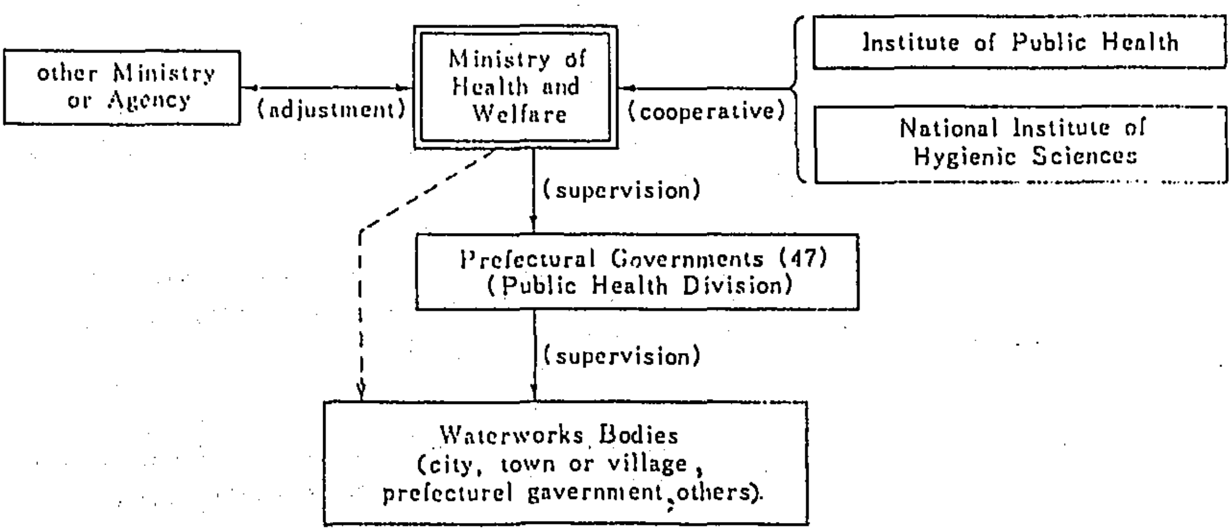



Fig. 5-1 Waterworks Administrative Organization

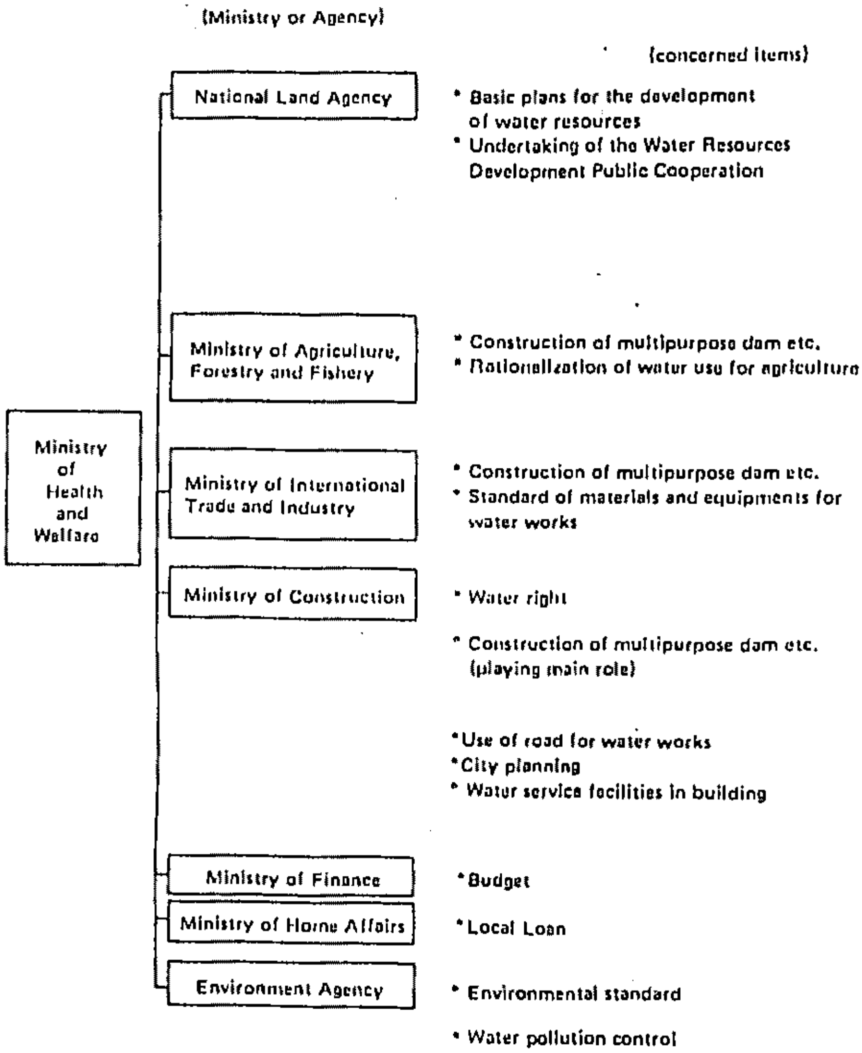



Figure-6 Ministries and Agencies of the Government Concerning Water Supply Administration

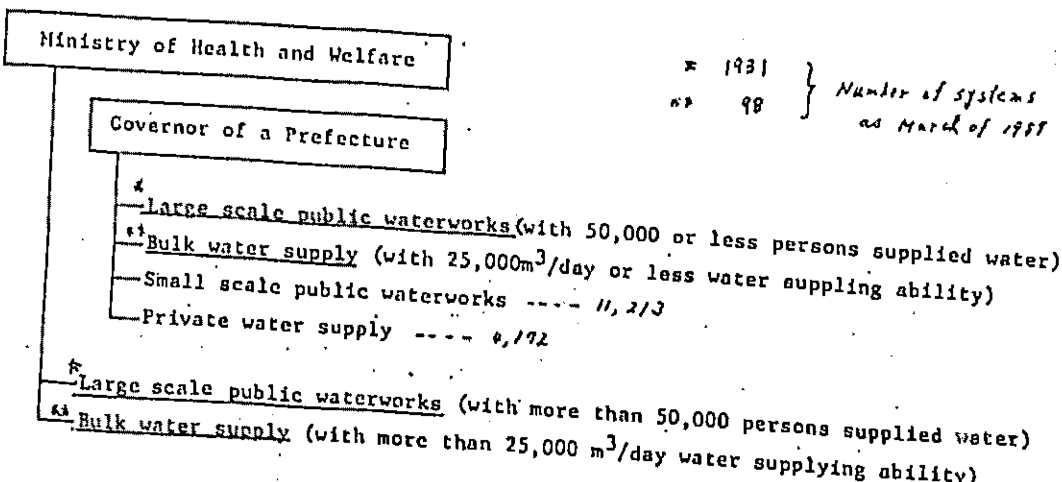



Fig. 5-2 Systems of Authorization and Supervision of Waterworks Bodies

Fig -7 Example of parties concerned and their responsibility

Case I : A-city water works — planned population 100,000; planned max daily supply 50,000 $m^3$/ day; water resource river (dam)

Case II : B-town small water works — planned population 3,000; planned max daily supply 900 $m^3$/d; water resource well

| responsibility | Case I: city | Case I: prefectural government | Case I: national government | Case II: town | Case II: prefectural government | Case II: national government (M.H & W) |
|---|---|---|---|---|---|---|
| ① make a plan for water supply system | ○ | | | ○ | | |
| ② establishment of design criteria | | | ○ | | | ○ |
| ③ approval of the plan | | (prior check and guidance) | ○ | | ○ | |
| ④ construction of the planned facilities | ○ | | | ○ | | |
| ⑤ subsidy for water resources development and sludge treatment facility | | | ○ ( Ministry of Local Autonomy) | | | ○ (subsidy to all facilities) ( Ministry of Local Autonomy) |
| ⑥ permission of flating a loan | | | | | | |
| ⑦ permission of water right for water - intake from river | | | (Ministry of Construction) | - | - | - |
| ⑧ appointment of technical manager with qualification as provided by the Low | ○ | | (offer trainning caurses) | ○ | | (offer trainning caurses) |
| ⑨ eatablishment of water quality standard | | | ○ | | | ○ |
| ⑩ testing of water quality | ○ | (institute of sanitation and health center) | *(subsidy to labo-ratory, apparatus) | ○ | (institute of sanitation and health center) | *(subsidy to labo-ratory, apparatus) |
| ⑪ guidance to maintenance and advice to reorganize the water works | | ○ | ○ | | ○ | ○ |
| ⑫ establishment of water supply regula-tions (including water charge) | ○ | | | ○ | | |
| ⑬ management of water works | ○ | | | ○ | | |

* in case of co-operative labo-ratory center.

Fig-2, A chronology of Japan's Water History

1590 The first conduit "Kanda Jousui" was completed in Edo (Tokyo). L=20km.

1822 First outbreak of cholera in Nagasaki(the biggist harbour at that time)

1853 The operning of Japan to foreign contacts.

1859 Yokohama harbour was opened to foreign ships .

1868 Meiji Era began. Edo changed its name to Tokyo.

1877 Big outbreak of cholera spread from Nagasaki all over Japan.
13,816 patients 8,027 dead.

1878 Drinking Water Caution Act was enacted (securing sanitary conditions of wells)

1879 Big outbreak of cholera all over Japan, 162,637 patients, 105,786 dead.

1883 Kanagawa Prefectural Government asked Mr. H.S Palmer to design a water supply system in Yokohama .

1885 Construction of Yokohama water supply system started.

1887 · The Government issued the instruction that water supply system and their construction should be put under municipal control.

· Central Hygiene Institution appealed to the Government for the promotion of modern water supply system.

· Water supply system in Yokohama came into operation.

1888 Governmental subsidy system for urban water system started( continued to 1954).

Municipal, town and village system started in Japan.

1889 Second modern water supply system was completed in Hakodate by Japanese Engineer(Seijiro HIRAI).

1890 Waterworks Ordinance (Old Water Works law) was promulgated.

1898 Water supply system in Tokyo came into operation.

1910 45 water supply systems had come into operation , population served were 2,131 ×1000(4.3%)

1911 First rapid sand filtration plant in Japan was constructed in Kyoto.

1913 Water meter first manufactured.

1915 Centrifugal pump first manufactured was introduced in Taichu City (Taiwan)

1917 Production of liquid chlorine was started.

1918 Governmental subsidy system for town/village water supply in the suburbs of large cities started.

1921 Chlorination was begun in Tokyo , Osaka and South Manshu Railway Company.

1930 High quality cast iron pipe was manufactured by Kubota Company.

1932 Water Works Association founded.

1938 Ministry of Health and Welfare founded.

1945 World War II ended.

357 urban water supply works had been established , population served was 25,110×1000 (34.8 %)

1952 Governmental subsidy for rural water supply system started.

1953 Maintemance manual of water supply system was first issued by the Ministry of Health and Welfare.

1955 Design criteria of water supply system was first issued by Japan Water Works Association.

1957 The Water Works Law was promulgated.

1958 The Water Quality Conservation Law was promulgated.

1960 10-year Plan for development of water supply systems was made by the Ministry of Health and Welfare.

1961 The Water Resources Development Act was promulgated.

1965 18,845 water supply system had been established , population served was 68,242×1000 (69.4 %)

· Environmental Advisory Committee founded by the Minister of Health and Welfare. The Minister questioned " a way of regrouping of water works."

1967 Governmental subsidy system for water resouces and regional wide water supply systems (mainly bulk water supplies) started.

1971 Establishment of Environment Agency

1974 Water supply and Environmental Dep. was organized in theMinistry of Health and Welfare.

1977 Amendment of Water Works Law

1984 The Advisory Committee of Living Environment submitted the report titled " Policies for the water services for the future" to the Minister of Health and Welfare.

1988 Japan Water Pipes Systems Research Center was created for research and development of pipes system.

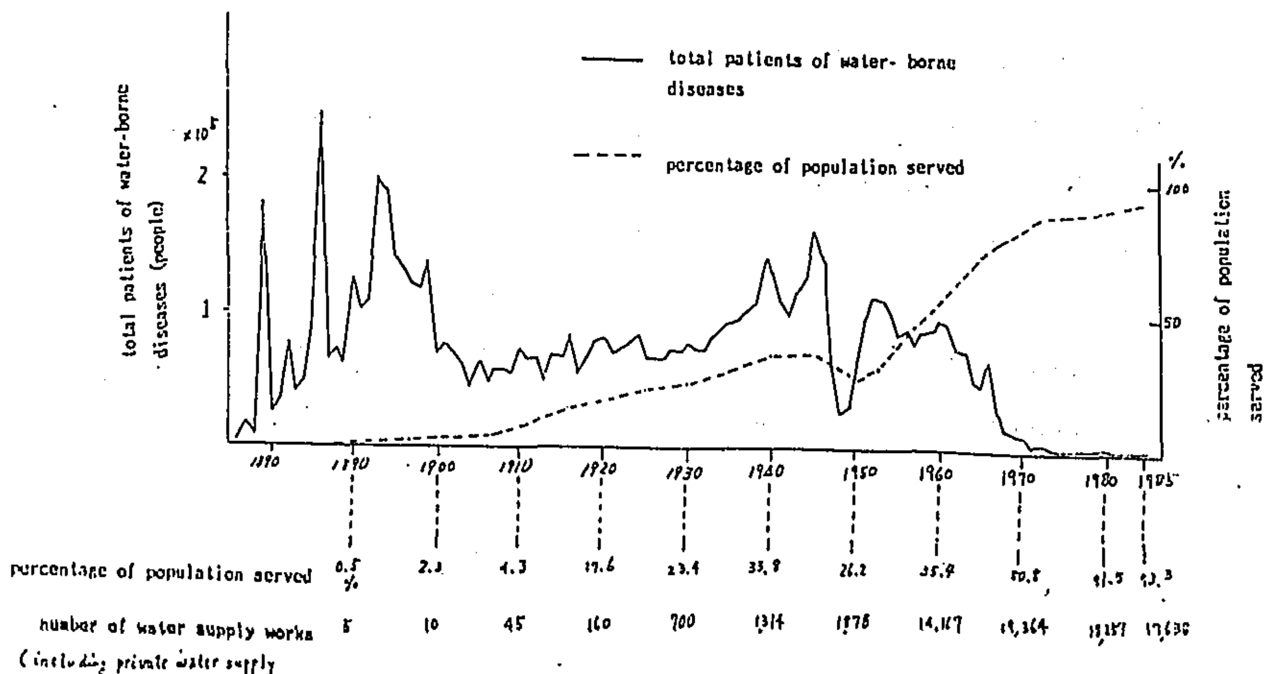



Fig-9 water-borne diseases and modern water supply in Japan

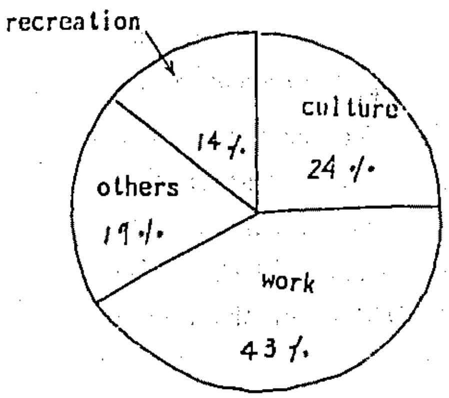



Fig-10 practical use of time saved by small water supply system

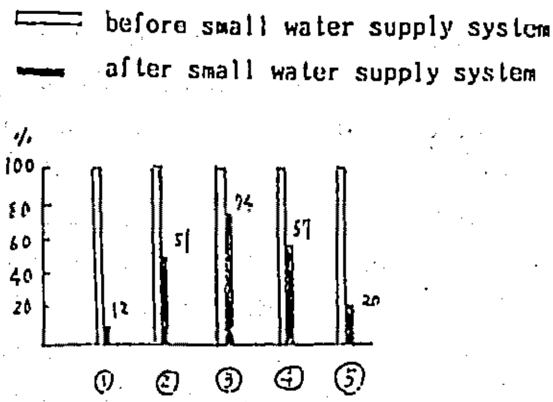



Fig-11 example of decrease in number of epidemic diseases, infant mortality, medical cost, damage from a fire etc. by small water supply systems

<NOTE> ① patients of epidemic desease
② patients of trachoma
③ infant mortality
④ medical cost
⑤ damage from a fire

| CITIES | DEATH RATE DUE TO TYPHOID FEVER DYSENTERY AND CHOLERA. (PER 10,000 PERSONS) | | | CRUDE DEATH RATE (PER 10,000 PERSONS) | | |
|---|---|---|---|---|---|---|
| | AVERAGE (BEFORE WATER SUPPLY) | AVERAGE (AFTER WATER SUPPLY) | INCREASE OR DECREASE | AVERAGE (BEFORE WATER SUPPLY) | AVERAGE (AFTER WATER SUPPLY) | INCREASE OR DECREASE |
| TOKYO METRO. CITY | 7.93 | 3.83 | -4.10 | 205.5 | 186.0 | -16.9 |
| OSAKA CITY | 19.44 | 8.95 | -10.49 | 243.5 | 241.2 | -2.3 |
| YOKOHAMA CITY | 93.46 | 11.74 | -81.72 | 433.7 | 226.9 | -206.8 |
| KOBE CITY | 30.66 | 8.03 | -22.63 | 262.5 | 245.3 | -20.2 |
| NAGASAKI CITY | 44.40 | 14.17 | -30.23 | 236.2 | 176.1 | -60.1 |
| HIROSHIMA CITY | 40.53 | 4.22 | -36.31 | 214.3 | 188.6 | -25.7 |

(from HIROSE and ISHIBASHI)

Table - 2 Interrelationship between establishment of water supply, and death rate due to typhoid fever, disentery and cholera, and crude death rate in Japan

## 3. Waste management administration in Japan

### 3.1 History of waste management in Japan

Early in Meiji Era(1868 ~1912), when infectious diseases, such as cholera and typhoid fever were prevalent, waste disposal was taken up from the point of view of public health, as it related to the prevention of such diseases. Particularly , with development of the industries after the Shina-Japanese War(1894~95), the urban population had continually increased , and the contamination of the living environment due to waste, had come to the front. Thus , in 1900, the "Filth Cleansing law" was promulgated , and the resposibility of waste disposal was placed upon the municipalities.

After the second World War , especially since 1949 , chemical fertilizers had come to be used extensively, and the mode of living in rural areas had been modernized. This resulted in a sharp decline in the utilization of night soil as a fertilizer. On the other hand , urban communities had been changed greatly due to the economic development. To carry out the cleansing scheme in response to such a social situation ,the Filth Cleansing Law was abolished , and the "Public Cleansing Law " was newly enacted in 1954.

Thereafter , with the expansion of the industrial activities , including the remarkable development of the heavy and petrochemical industries on one hand, and the improvement of the living standard on the other , wastes have increased greatly in quantity , and changed in character. Particularly , most industrial wastes now include hazardous and difficult substances to manage , have caused environmental pollution . In such a situation , it was necessary to amend the Public Cleansing Law to place the responsibility for the adequate management of industrial wastes on each enterprise. Thus , the " Waste Disposal and Public Cleansing Law" (hereinafter referred to as "Waste Disposal Law") was enacted on 18th December,1970, and made effective on 24th September , 1971 , along with the promulgation of the related Cabinet Orders and Ministerial Ordinances. This Law was amended in 1976, in order to consolidate a control system for solid waste management and strengthen the control on industrial wastes.

The "Jokaso(indivisual sewege disposal tank)Law" was enacted in 1983 to extend the Jokaso systems.

### 3.2 Legislation and Organization on waste management administration

1) Legislation

The basic law concerning waste is the Waste Disposal Law , and many laws concerning waste management exist.

Fig-12 shows laws concerned with various aspects of waste management.
The Waste Disposal Law was established in 1970 succeeding to the Public Cleansing law of 1954 and , amended in 1976 mainly to strengthen the control on indust

-rial wastes and facilities for final disposal .

The purpose of this law is to preserve the living environment and to improve public health through the appropriate disposal of wastes and conservation of clean environment. The Law are -----

a) categorizes wastes as follows

"Waste" refer to refuse ,bulky refuse, ashes, sludge, human excretion, waste-oil, waste acid and alkali, carcasses, and other unclean and unneeded materials, which are in a solid or liquid state (excluding radioactive waste or which is polluted by radioactivities).

(1) Industrial wastes

Industrial waste are those which are dischaged in connection with trade and industrial activities. They are shown Fig-13.

(2) Domestic wastes

The domestic waste are those other than industrial wastes.

They are shown Fig-13.

b) prescribes duties/responsibility of the concerned parties (the enterpriser, municipalities, prefectural governments, national govrnment).

c) defines municipal waste treatment facilities and industrial waste treatment facilities and their construction plan shall be notified to prefectural governor or city mayor prior to construction.

d) establishes standards related to waste management and obligates persons to observe them.

2) Organization and Responsibility

· The national govervment's office principally responsible for waste disposal is the Ministry of Health and Welfare ; The administrative structure related to the waste disposal is shown Fig-14. The Ministry of Health and Welfare makes plans for the technical reseach and development on waste disposal, along with furnishing the necessary technical and finacial assistance to the municipal and prefectural government , for adequate performance of their duties.

And it also makes long term plan of the improvement of waste waste disposal facilities based on "Law on Urgent Promotion of Waste Disposal Facilities Construction".

The other related national government's office is Environment Egency.

The duties of the Sewerage and Sewerage Purification Dep. in the Ministry of Construction are : guidance and aid of sewerage management, and survey, guidance and aid of public sewerage projects, municipal sewerage projects and river basin sewerage projects.

· The duties of the enterpriser comprise 3 main objectives.

The first is the appropriate dispasal of the wastes resulted from the enterprising activity on his own resposibility. The second is to endeavor to lessen the amount of wastes by regeneration or reuse of wastes. The third is to take countermeasures ,so as not to impair the appropriate waste treatment of the products or the containers to be manufactured, processed and sold.

・The municipal governments endeavor to propagate the concepts of cleanliness and to execute waste treatment. They also endeavor to operate the disposal work efficiently , by improving the ability of the staff, consolidating disposal facilities and developing operation techniques.

The matters to be carried out by municipal government are as follows.

a. Installation and maintenance of public toilets and waste buskets ,
b. Establishment of a plan on the domestic wastes disposal,
c. Collection , transport and disposal of domestic wastes,
d. To give permissions to the bussiness undertaking industrial wastes disposal
e. Industrial wastes disposal , when necessary ,
f. Collection of reports concerning waste disposal , and etc.
g. Inspection.

・The prefectural government endeavor to give necessary technical advice to the municipalities for carrying out the adequate performance of the duties of municipalities , and endeavor to control the conditions of industrial wastes in the respective prefecture , along with provision of necessary measures.

The matters to be carried out by the prefectural governments are as follows.

a. Give technical advice to the municipalities
b. Taking hold of the condition of industrial wastes,
c. To order changes or abolishment of the construction of domestic and industrial wastes disposal plants,
d. To order improvement of the domestic and industrial wastes disposal plants, or suspension of their use.
e. Industrial wastes disposal , when necessary,
f. Publication of a plan on industrial wastws disposal,
g. To order changes of the industrial wastes disposal conducted by the enterprise,
h. To give permissions to the businesses undertaking industrial waste disposal
i. Collection of reports concerning wastes disposal and etc.
j. Inspection.

( see Fig-17)

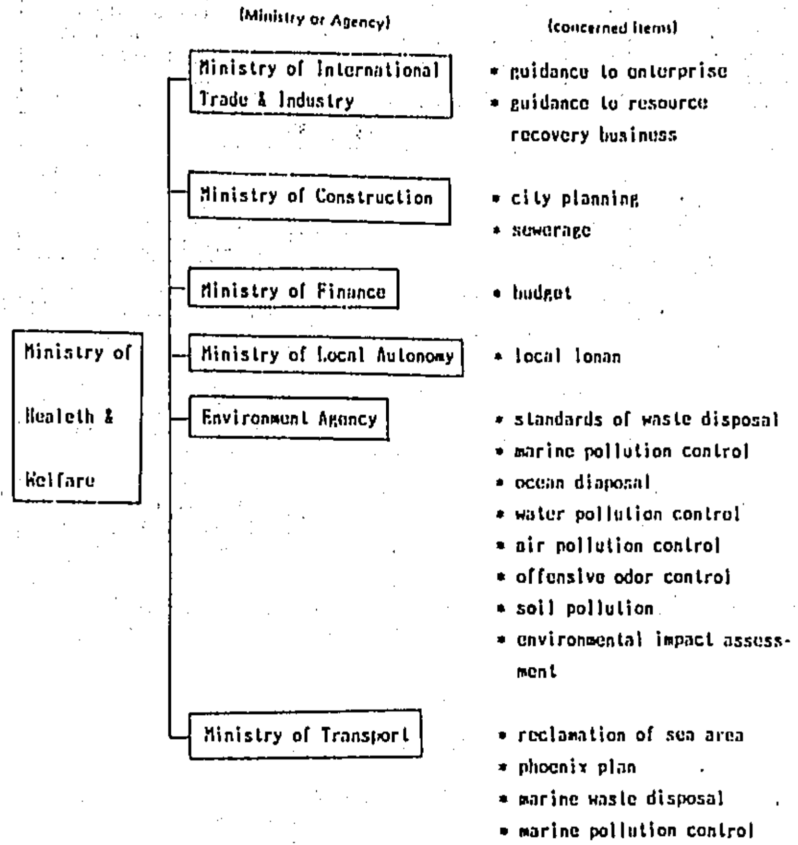



Fig-12 Ministries and Agencies of the Government concerning waste management

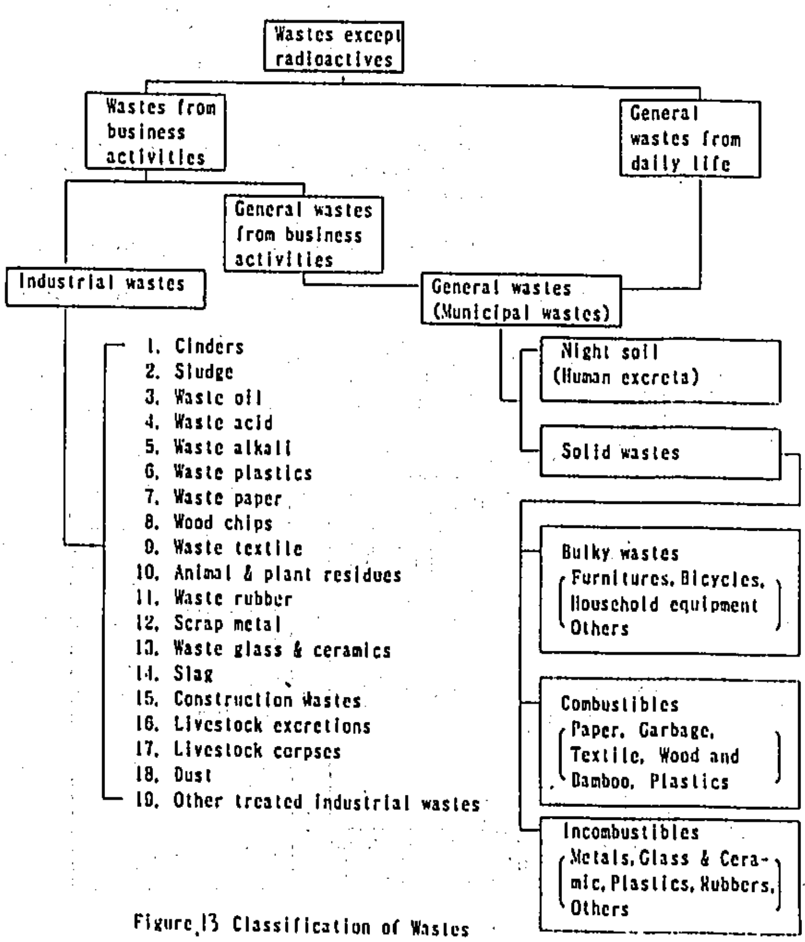



Figure 13 Classification of Wastes

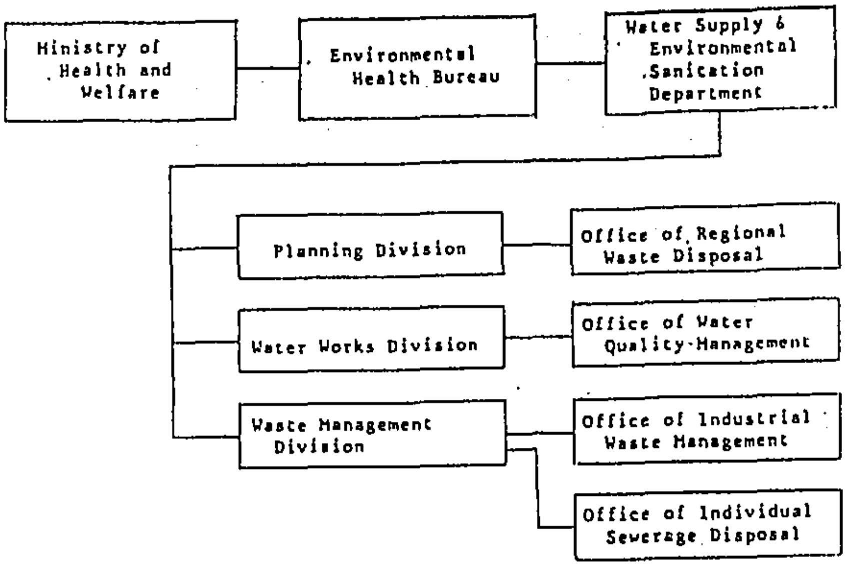
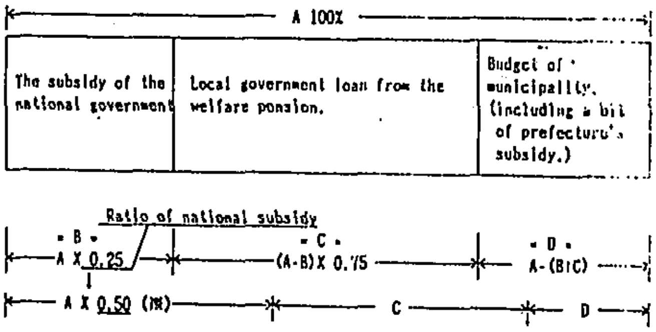



Figure 14: STRUCTURE RELATED TO THE WASTE DISPOSAL IN THE MINISTRY OF HEALTH AND WELFARE




(※)
Ratio of national subsidy for the municipality which the national government designate as strict pollution control area, stipulated by " Special Financial Aid for Pollution Control Law "

Remarks : Half of loan is refunded by local grants (Kofu zei).

Figure 15 Composition of Incinerator Construction Cost

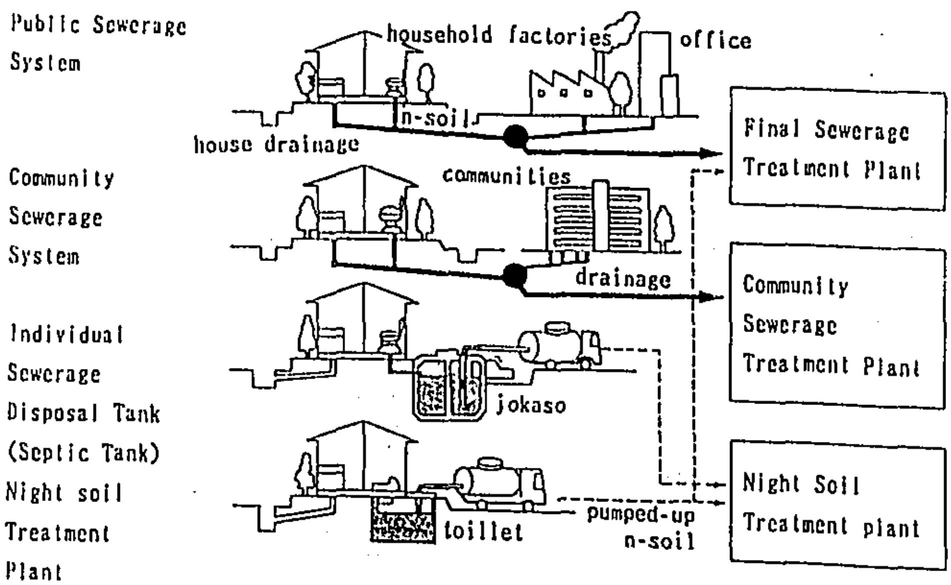



Figure 16 Flow of Night Soil Disposal

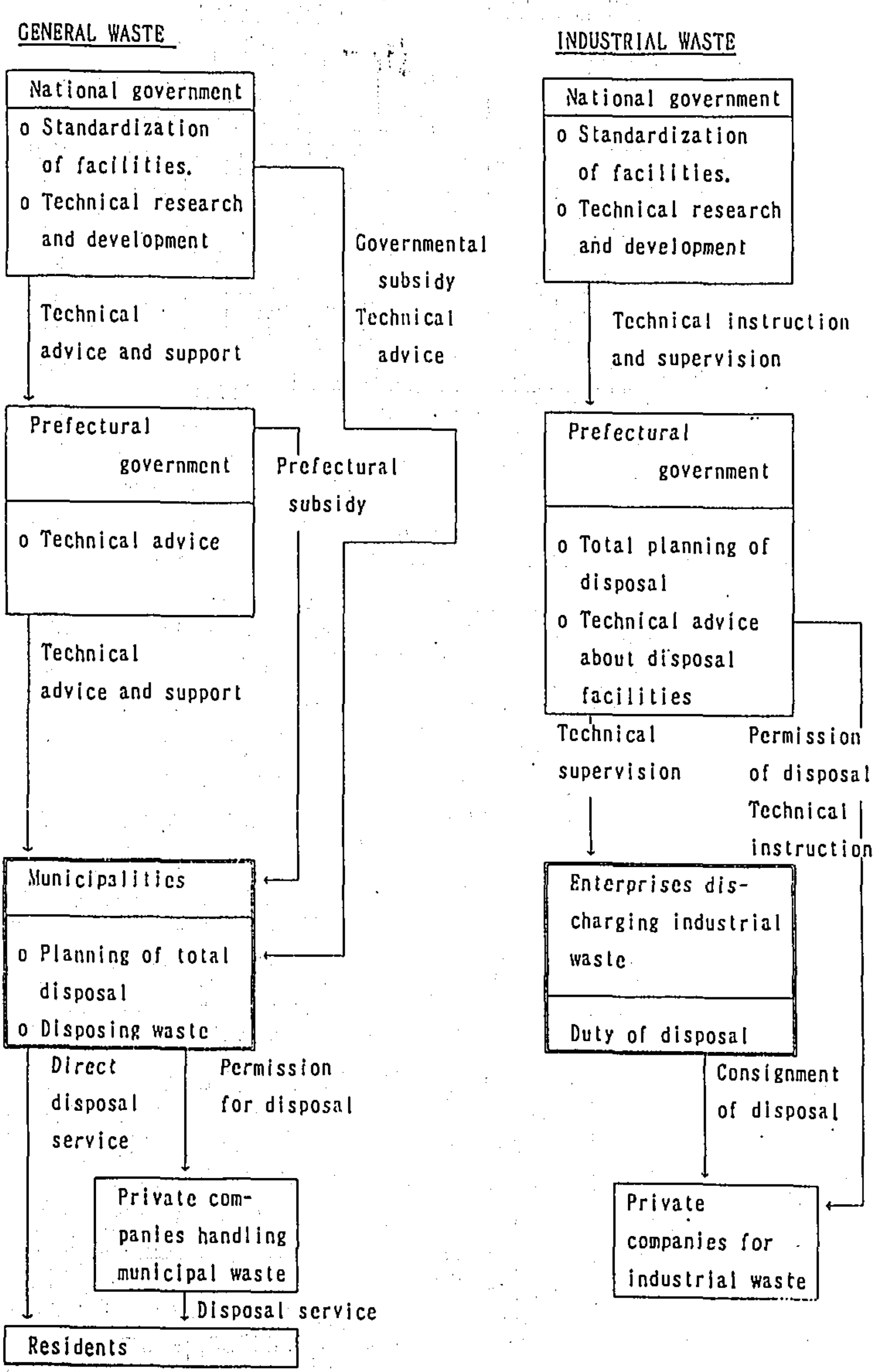



Figure-17 Flow of Waste Management

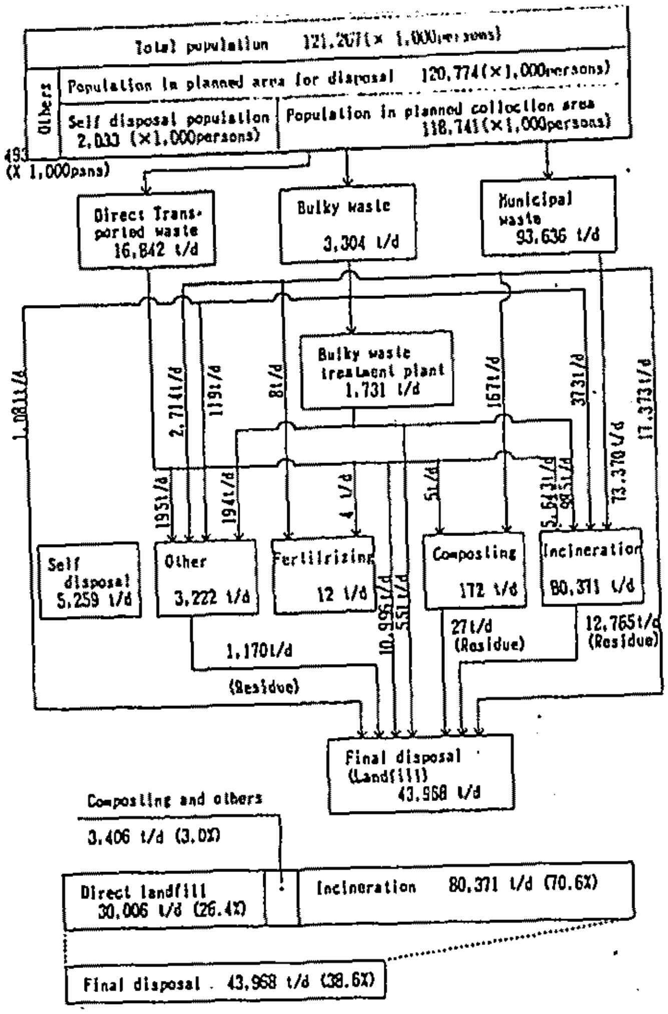



Figure 18 Flow of Solid Waste Disposal (in FY 1985)

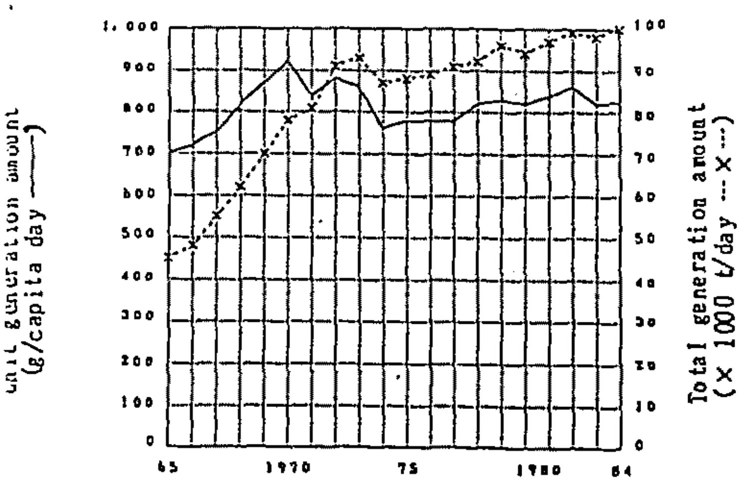



Figure 17 Trend of Total and Unit Generation Amount

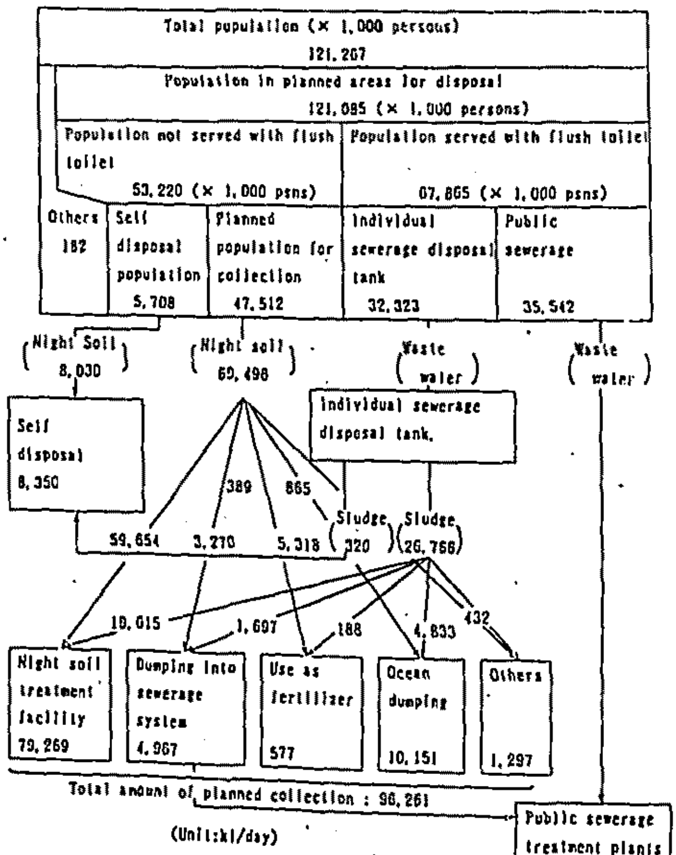



Figure 20 Collection-to-Disposal Flow of Night Soil (in FY 1985)

## Fig-21 Historical Development of Japan's waste management

1877 Widespread cholera , 13,816 patients , 8027 dead

1897 Promulgation of Epidemic Control Law , Waste Cleansing Law and Sewerage Disposal Law .

1901 Public Collection of solid waste was started in Tokyo.

1911 Public Collection of night soil was started in Tokyo.

1924 First refuse incineration plant was constructed in Osaki/Tokyo.

1933 First night soil disposal plant was constructed in Ayase/Tokyo.

1945 The second World War ended.

1954 Promulgation of Public Cleansing Law .

1957 " Dream Island " for reclamation initiated in Tokyo.

1958 (New) Sewerage Disposal Law was promulgated.

1960 Waste Management Division was founded in the Ministry of Health and Welfare.

1965 First 5-year plan for Development of Waste Treatment Facilities was decided by Cabinet Order. (Planned Investment for solid waste teratment was 45 billion Yen, 1963 ~1967)

1967 Promulgation of the Basic Law for Pollution Control Law.

1968 2nd 5 year Plan was established by Cabinet Order.
(Planned Investment , 133 billion Yen , 1967 ~1971)

1971 Promulgation of Waste Disposal and Public Cleansing Law.
Environment Egency was inaugurated.

1973 Office of Industrial Waste, Ministry of Health and Welfare , was founded
Oil-crisis occurred.

1974 Water Supply and Sanitation Department , Ministry of Health and Welfare was inaugurated.

1975 3rd Long Term Plan (Planned Investment, 402 billion Yen , 1972~1975)

1976 4th 5-year Plan (Planned Investment, 1,130 billion Yen , 1976 ~1980)

1980 Office of Regional Planning for Waste Disposal was founded , in M of H & W, 5th 5-year Plan (Planned Investment, 1,760 billion Yen , 1981~1985)

1981 The Law of Regional Offshore Environment Improvement Center was enacted ( large area waste disposal law)

1983 Individual Sewerege Disposal Law( Jokaso Law ) was promulgated

1986 6th 5-year Plan ( Planned Investment , 1,910 billion Yen, 1986~1990)

Appendix 1.

## Procedure of Phoenix Project

Minister of Health and Welfare designates the covering area of Phoenix Project.

Minister of Transport designates the ports for the coastal landfill sites.

↓ More than ten local governors and port authorities become promotors. They prepare the articles of the Regional Offshore Environmental Improvement Center and collect the investment.

The two Ministers approve the establishment of the Center.

↓

The Center is established.

↓

The Center makes the master plan.

→ negotiating with the local governments and port authorities

→ approvement by the Ministers

↓

The Center makes the practical plan.

→ negotiating with the local governments and port authorities

→ submitting to the Ministers

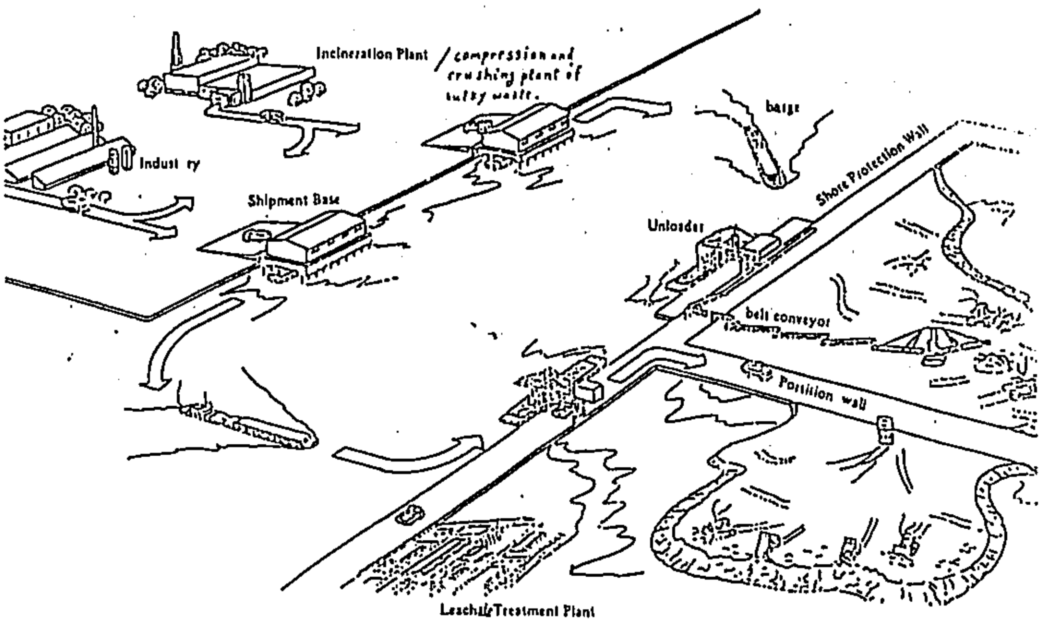
↓

The Center constructs the coastal landfill sites and other necessary facilities.

↓

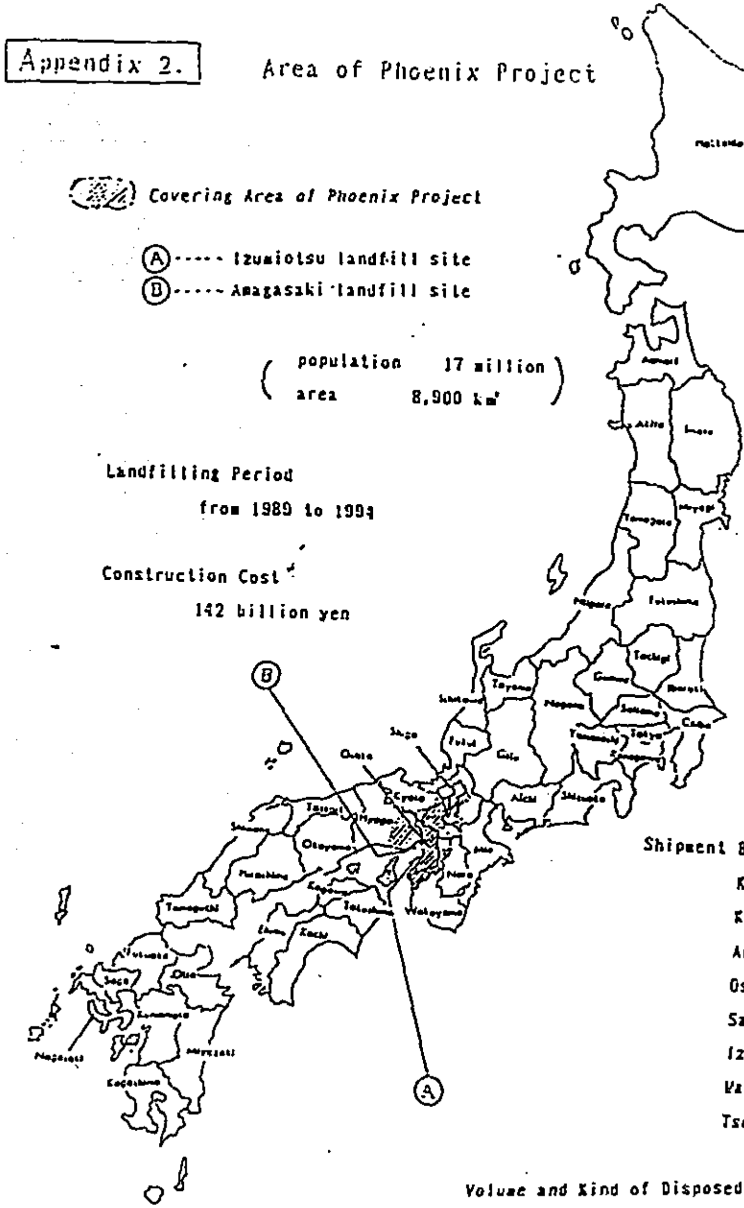
The Center disposes of waste at the coastal landfill sites.

Fig.1 . Outline of a Regional Disposal System



Appendix 2.

## Area of Phoenix Project



(hatched) Covering Area of Phoenix Project

Ⓐ----- Izumiotsu landfill site

Ⓑ----- Amagasaki landfill site

( population 17 million
area 8,900 km² )

Landfilling Period
from 1989 to 1994

Construction Cost
142 billion yen

Shipment Bases

| | | |
|---|---|---|
| Kakogawa | 1,700 | ton/day |
| Kobe | 6,700 | |
| Amagasaki | 12,000 | |
| Osaka | 12,000 | |
| Sakai | 9,900 | |
| Izumiotsu | 5,000 | |
| Wakayama | 2,100 | |
| Tsuna | 110 | |

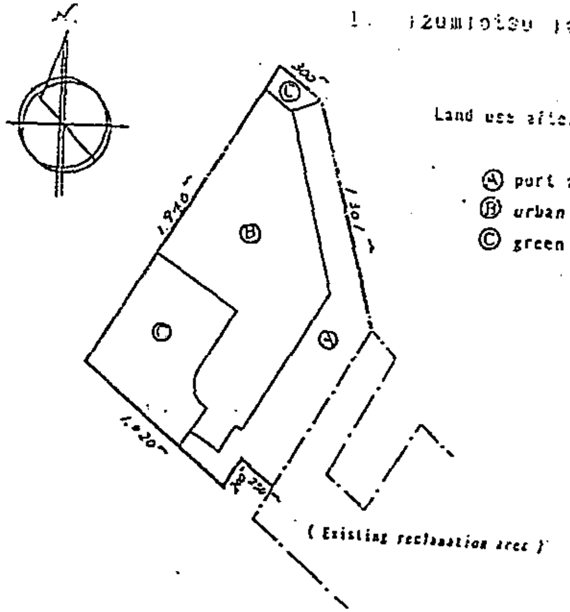
Volume and Kind of Disposed Waste

| | | |
|---|---|---|
| domestic waste ( household waste ) | 4.3 | million m³ * |
| industrial waste | 12.0 | ** |
| soil discharged by construction activities | 21.9 | |
| dredged sand | 6.8 | |
| total | 45.0 | million m³ |

| | | |
|---|---|---|
| Ⓐ Izumiotsu | 203 ha, | 30 million m³ |
| Ⓑ Amagasaki | 113 ha, | 15 million m³ |

Appendix 3.

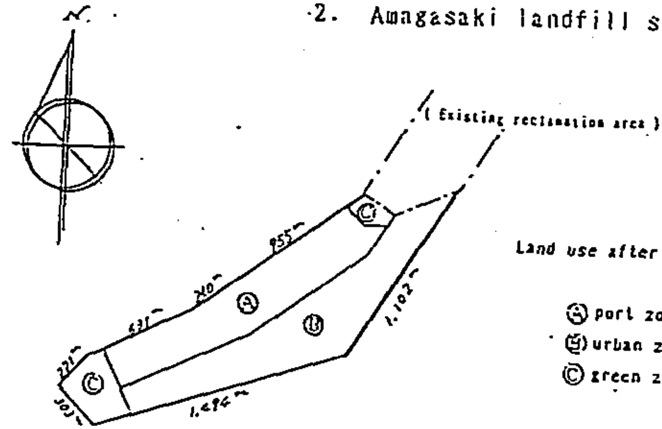
### 1. Izumiotsu landfill site




Land use after landfilling

| | | |
|---|---|---|
| Ⓐ port zone | 58 | ha |
| Ⓑ urban zone | 95 | ha |
| Ⓒ green zone | 50 | ha |

### 2. Amagasaki landfill site




Land use after landfilling

| | | |
|---|---|---|
| Ⓐ port zone | 43 | ha |
| Ⓑ urban zone | 57 | ha |
| Ⓒ green zone | 13 | ha |

* Municipalities shall incinerate the combustible domestic waste and crush the bulky domestic waste before carrying them to the shipment bases of the Osaka Bay Center. The volume of domestic waste described above is the volume of ash, cinder and crushed uncombustible domestic waste.

** The Osaka Bay Center doesn't receive the industrial waste containing hazardous substances at the shipment bases.

# MANPOWER DEVELOPMENT IN WATER SUPPLY AND ENVIRONMENTAL SANITATION SECTORS IN JAPAN

Dr. Shoichi KUNIKANE

Head, Facilities Planning & Management Section,
Department of Sanitary Engineering,
National Institute of Public Health
Ministry of Health and Welfare
Government of Japan

COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR
Jakarta, 27 - 28 February 1989

# MANPOWER DEVELOPMENT IN WATER SUPPLY AND ENVIRONMENTAL SANITATION SECTORS IN JAPAN

Shoichi KUNIKANE
Institute of Public Health

## INTRODUCTION

Human resources are the most important factor for the development of water supply and environmental sanitation sectors. If it is allowed to say that Japan has succeeded in developing water supply and environmental sanitation systems all over the country, this is largely owed to education and training of engineers engaged in these sectors. The history of the sector development reflects the history of manpower development.

In this paper, the history, current status and future prospects of manpower development in water supply and environmental sanitation sectors in Japan are reported. Special attention is payed to the activities of the Institute of Public Health(IPH), Ministry of Public Health, because it has contributed significantly to manpower development in these two sectors in Japan.

## OVERVIEW

The education of sanitary engineering as a part of civil engineering started at Tokyo University in 1896. The Institute of Public Health(IPH), which belongs to the central government, was established in 1938, and it started the training of public health personnels in 1939. At that time ,the subject of sanitary engineering was included in the curriculums of the courses like medical science, but the Sanitary Engineering Course for 3 months was newly opened in 1948. Since then, the IPH was the only institution for education and training of sanitary engineers in Japan before the Department of Sanitary Engineering was established at Hokkaido University in 1957. After that, the Department of Sanitary Engineering was also established at Kyoto University in 1958, and the Sanitary Engineering Course as a part of the Department of Urban Engineering at Tokyo University in 1962. The total capacity of the departments/course in these universities is about 120 per year. Lectures and practices of sanitary engineering are also given mainly in a department of civil engineering in some other universities. However, all of the university education is very different from that of the IPH, because it is only for the students who have no experience in practical works.

Today the total manpower in the water supply and environmental sanitation sectors in Japan increased up to approx. 200,000 as shown in TABLE 1. It is not clear how many engineers are there in these two sectors. However, it is estimated that approx. 26,500 personnels out of 66,500 personnels in large water supplies are engineers. TABLE 2 shows the current activities of personnel training in water supply and environmental sanitation sectors in Japan. The training by the IPH is very few in capacity, but it is more intensive than any other ones. After 1965, some of large water supplies such as Tokyo Metropolitan Waterworks Bureau and Nagoya City Waterworks Bureau started a systematic training of their personnels.

TABLE 1 MANPOWER IN THE WATER SUPPLY AND ENVIRONMENTAL SANITATION SECTORS IN JAPAN

(unit:persons)

| | |
|---|---|
| Water Supply | |
| Large water supply | 66,500 |
| Bulk water supply | 4,500 |
| Small water supply | 5,500 |
| Private water supply | 6,000 |
| Prefectures and municipalities | 4,000 |
| total | 86,500 |
| Environmental Sanitation | |
| Municipalities | |
| Solid waste management | 78,500 |
| Night-soil management | 18,500 |
| sub-total | 97,000 |
| Prefectures | 3,500 |
| total | 100,500 |

Note) The manpower in private sectors is not included.

## CONTRIBUTION OF THE INSTITUTE OF PUBLIC HEALTH (IPH)

### History

The description on the history of the IPH in its Announcement(1988) is cited below:

TABLE 2 TRAINIG OF PERSONNELS IN WATER SUPPLY AND ENVIRONMENTAL SANITATION SECTORS IN JAPAN

| (Institution) | (trainees) | (capacity) | (duration) |
|---|---|---|---|
| <u>Water Supply</u> | | | |
| Institute of Public Health | only engineers | 30 | more than six weeks |
| Japan Water Works Association | all levels including administrators | 3,060 | mostly less than one week |
| Japan Small Water Works Association | all levels including administrators | 1,150 | less than three days |
| <u>Environmental Sanitation</u> | | | |
| (Institution) | (trainees) | (capacity) | (duration) |
| Institute of Public Health | only engineers | 40 | more than one month |
| Japan Environmental Sanitation Center | engineers and technicians | 10,310 | less than two weeks |
| Japan Education Center of Environmental Sanitation | engineers and technicians | 6,460 | less than two weeks |
| Japan Waste Management Association | all levels including adminstrators | 1,710 | one day |

Note 1) The unit of capacity is persons per year.
2) Trainings in each municipality, water works, etc. are not listed here.

# HISTORY

The Institute of Public Health was established in March 1938 under the administration of the Ministry of Health and Welfare of the Japanese Government for the purpose of training public health personnel and performing research works on public health. The buildings and equipments of the Institute were donated by the Rockefeller Foundation.

The first one-year courses were offered in April 1939 for graduates from medical schools and for those from schools of pharmacy. Then a four-month course for graduates from schools of veterinary medicine was added in September 1939. In December 1940, another four-month course of public health nursing and in April 1941, a nine-month course of nutrition and its advanced course were opened.

In addition to the above courses, short courses of various fields were offered for public health workers who were already in active service.

The Institute met, however, with increasing difficulties in keeping the training activities during World War II. A part of the building was then occupied by the Ministry of Health and Welfare. Finally all of the courses were suspended in 1944.

Educational activities after the War were reopened in 1946 to meet the need of conquering the prevailing post-war situation. Various specific refresher courses of a few months' duration were opened for health officers in key posts and for auxiliary personnel needed to staff in health centers.

Such a course was first begun for public health nurses in April 1947, and six special courses of various fields were initiated in the next year for medical health officers, sanitarians, sanitary engineers, public health veterinarians and public health pharmacists. Since 1948 other refresher courses have been conducted for public health statisticians, health educators and technical workers in prefectural health laboratories.

In April 1949, a regular one-year course for graduates from medical schools was reopened. Then in 1951 six-month courses for veterinarians, pharmacists and dieticians were started again.

In April 1956, the programs of the training courses were reorganized and three new regular one-year courses were opened. In 1964 those regular one-year courses were divided into five courses: General Public Health Course, Environmental Sanitation Course, Nursing Course, Health Education Course and Nutrition Course. Furthermore, in 1967 Environmental Pollution and Noise Control Course of one year's term was started and in 1972 the name of this course was changed to Environmental Sciences Course.

In April 1971, special courses of various fields were reorganized and since then, these courses have been conducted for public health personnel already in service. In order to cope with recent progress in health science and technology, certain specific subjects are selected for the purpose of continuing education.

In view of rapid changes in social, economic and environmental conditions, previous programs of education at the Institute were completely renewed in 1980. Now, the Institute offers four kinds of educational courses. Among them, the courses leading to the Master of Public Health of two years' duration and leading to the Doctor of Public Health of three years' duration have been newly organized to provide public health professionals with more advanced and more specific knowledge and skills to cultivate high standard capabilities essential for the professionals and specialists in public health. One year's course leading to the Diploma in Public Health provides graduate students and personnel already in service with theoretical knowledge and practical experience essential for public health personnel in leading positions. Special courses of shorter duration, one month in average, are offered for the purpose of continuing education in public health. The subjects and curricula of the courses are reviewed every year according to recent progress and practical needs in public health fields.

An International Cooperation Program is now under consideration, which will be organized for foreigners to promote public health in the world in cooperation with WHO.

At the time of IPH's establishment, the Municipal and Rural Health Centers were also established in different places for the purpose of practical training of the students. The IPH trained approx. 24,000 public health personnels since it was established. Most of its graduates get(got) very important positions in central/local governments and other organizations because they are(were) highly qualified, and are contributing(contributed) largely to the development of water supply and environmental sanitation systems in Japan. The IPH was celebrated for its 50 years' anniversary in 1988. The IPH is recognized as a post-graduate public health school by the World Health Organization.

The features of the IPH's training may be summarised as follows:

1. post-graduate and high-leveled(i.e. not only information transfer)
2. practical and multi-disciplinary

## Current status

The present organization of the IPH is shown in FIGURE 1. There are 16 academic departments including the Department of Sanitary Engineering. A dormitory is provided for accomodation of students and trainees. The number of researching(educating) staffs is approx. 115. Now the IPH offers four different types of courses as follows:

FIGURE 1 ORGANIZATION OF THE INSTITUTE OF PUBILIC HEALTH

- Director General
  - Vice Director General
- Department of General Affairs
- Department of Public Health Statistics
- Department of Public Health Demography
- Department of Physiological Hygiene
- Department of Nutrition and Biochemistry
- Department of Epidemiology
- Department of Public Health Microbiology
- Department of Sanitary Engineering
- Department of Architectural Hygiene Engineering and Housing
- Department of Pharmaceutical Sciences
- Department of Veterinary Public Health
- Department of Maternal and Child Health
- Department of Industrial Health
- Department of Public Health
- Department of Public Health Nursing
- Department of Radiological Health
- Department of Community Environmental Sciences
- Library

1. Course Leading to the Diploma in Public Health
2. Course Leading to the Master in Public Health
3. Course Leading to the Doctor in Public Health
4. Special Courses for Continuing Education in Public Health

Foreigners can also be students of the former three courses. The detailed descriptions of the above courses are cited below from the Announcement(1988).

## COURSE LEADING TO THE DIPLOMA IN PUBLIC HEALTH

*Objective:*

This Course is intended for those who are engaged in or intend to get engaged in any relevant service to public health, and to give them instruction in public health theory and practice, so as to let them acquire theory essential for leading public health personnel in the fields of environmental science, public health nursing or health science and to develop their capabilities to put it into practice.

*Disciplines:*

The Course leading to the Diploma in Public Health consists of three disciplines.

(1) Environmental Science
(2) Public Health Nursing
(3) Health Science

*Duration:*

The length of time required to complete the course is 1 year.

*Requirements for the Diploma:*

In order to obtain the Diploma in Public Health candidates must have: (1) completed the required period of full-time study in residence at this institute; (2) successfully completed the approved schedule of studies with 27 credit units or more.

*Number of students to be admitted:*

| | | |
|---|---|---|
| (1) | Environmental Science | 15 |
| (2) | Public Health Nursing | 20 |
| (3) | Health Science | 15 |

## COURSE LEADING TO THE MASTER OF PUBLIC HEALTH

*Objective:*

This Course is intended to give students instruction in profound knowledge and practical skills in public health, getting things in perspective, so as to develop their high-degree capabilities essential for the public health professional careers.

*Duration:*

The length of time required to complete the course is 2 years.

*Requirements for the Degree:*

In order to obtain the Master of Public Health degree candidates must have: (1) completed the required period (2 years) of full-time study in residence at this institute; (2) successfully completed the approved schedule of studies with 30 or more credit units, including the required instruction or laboratory work, and the practical field experience, however, a minimum of one year or more of full-time residency may be approved for those who are medical doctors or dentists, or who possess a graduate degree of Master, on condition that they have successfully completed 25 or more credit units fulfilling the prerequisites; (3) submitted an acceptable thesis; (4) passed the required examinations conducted by the Education Council of this institute.

A master candidate who completed the Diploma in Public Health degree course at this institute after 1980 academic year can apply some of the completed credit units in the course to the required number of credit units in this course.

*Number of students to be admitted:* 10

## Course Leading to the Doctor of Public Health

*Objective:*

This Course is intended to develop students' professional capabilities essential for public health specialists in their own conduct of research activities as well as extensive knowledge basic to such research performance.

*Duration:*

The length of time required to complete the course is 3 years.

*Requirements for the Degree:*

In order to obtain the Doctor of Public Health degree candidates must have: (1) completed the required period (3 years) of full-time study in residence at this institute; (2) successfully completed the approved schedule of studies, including field research or laboratory work, however, a minimum of one year or more of full-time residency may be approved for those who have produced excellent research achievements; (3) submitted an acceptable thesis; (4) passed the required examinations conducted by the Education Council of this institute.

A doctoral candidate who did not complete the Master of Public Health degree program at this institute is required to complete 10 credit units in the required special subjects (p. 16).

*Number of students to be admitted:* 5

## Special Courses for Continuing Education in Public Health

These Courses are intended for those who are engaged in relevant services to public health, and to give them opportunities of continuing education, so as to let them acquire the latest knowledge, techniques and technical skill on the specified subject of each field, which is examined year by year to meet the demands of the times.

The duration of most courses is approximately one month.

13 to 15 courses are offered every year.

Applicants should have enough background to be required in each course, however, Director General of this institute may approve those who have the equivalent background of each requisite.

The present system of training started in 1980. The number of graduates since this year is summarized in TABLE 3. Some of the students are not public health personnels sent from local governments and other organizations, but coming directly from universities after their graduation. All of the students of the long-term courses, i.e. the Diploma, Master and Doctor Courses,

TABLE 3 THE NUMBER OF IPH GRADUATES FROM FY 1980 THROUTH FY 1986

(unit: persons)

| | |
|---|---|
| Course Leading to the Doctor of Public Health | 6 |
| Course Leading to the Master of Public Health | 74 |
| Course Leading to the Diploma in Public Health | |
| Environmental Science | 35 |
| Public Health Nursing | 155 |
| Health Science | 35 |
| sub-total | 225 |
| Special Courses for Continuing Education in Public Health | 2,251 |
| total | 2,556 |

should submit a thesis for graduation. In the curriculum of the Diploma Course, a field training in public health by team approach is included. The trainers are mainly the researching staffs of the IPH, but others such as professors of universities, researchers of other institutions and experts in central/local governments are also invited when necessary. The arrangement of each course is made by a course leader and assistant course leaders, who are researching staffs belonging to the IPH and nominated for the course, with administrative support of the Education Management Division.

## Activities of the Department of Sanitary Engineering

The Department of Sanitary Engineering is responsible for training and research in the fields of water supply and environmental sanitation. The outline of the Department is described in the Announcement(1988) as follows:

### DEPARTMENT OF SANITARY ENGINEERING

*Sections*: Water Quality Engineering; Water Quality Examination; Solid Wastes Management; and Facilities Planning and Management.

The Department is responsible for education and research in the engineering field including public water supply, sewage and night soil treatment, and solid wastes management. The Department offers two education programs of Water Quality Management & Engineering and Solid Wastes Management. The main subjects being studied are: 1) Pollution of water sources and its assessment; 2) Behavior of micropollutants in the processes of water purification; 3) Removal kinetics of organic fractions of wastewater in biological treatment processes; 4) Simplification of water quality examinations; 5) Microbiological indicator of water pollution and control of infectious microorganisms; 6) Improvement of refuse collection system; 7) Environmental effects of heavy metals from landfill, 8) Formation and decomposition mechanisms of dioxins and related compounds, and 8) Risk assessment for waste management.

The Department is designated as a WHO Collaborating Centre for public water supply and sanitation as well as for solid waste management and also as a Regional Reference Centre for the GEMS/Water Project.

Although the total number of its staffs is nine at this moment, the activity both in training and research is very high. Because this Department is the only national organization which is responsible for research and personnel training in the sectors of water supply, solid waste management, night-soil management and domestic wastewater treatment(excluding sewage works). The Department currently offers the following two Special Courses:

## WATER QUALITY MANAGEMENT AND ENGINEERING

*General description:*

This course is intended to provide comprehensive knowledge of water quality management as well as the advanced technologies of water purification and wastewater treatment for the personnel being engaged in water quality management.

The full number of students is 20.

The duration of this course is 6 weeks.

*Background of Applicants:*

Those with the Bachelor's degree in engineering, science, medicine, pharmaceutics, agriculture or fisheries who have been engaged in water quality management in Government or local municipalities for three years or more.

*Curriculum:*

Water quality conservation
Water and environmental sanitation
Planning of water quality control system
Physical and chemical treatment
Biological treatment
Advanced treatment
Water supply system
Wastewater management system
Field study
Group study on selected subject
Seminar

## SOLID WASTE MANAGEMENT

*General description:*

This course is intended to provide comprehensive knowledge and techniques essential to appropriate management of municipal and industrial solid wastes including night soil treatment for the personnel being engaged in solid waste management.

The full number of students is 30.

The duration of this course is 5 weeks.

*Background of Applicants:*

Those with the Bachelor's degree in engineering, science, medicine, pharmaceutics, agriculture, or fisheries who have been engaged in solid waste management in Government or local municipalities for one year and more.

*Curriculum:*

- Solid wastes management planning
- Solid wastes management engineering
- Landfill disposal
- Environmental protection
- Group study on selected subjects

In both of these two courses, a group study on a selected subject for about 2 weeks and a 2-days field trip as well as lectures by eminent professors and experts are included in the curriculums. The subjects of group study for the Courses in 1988 are listed in TABLE 4. Some of the groups undertook experimental studies. At the end of each Course every group should submit a report on the selected subject and make presentation about the result. Since these Courses are so intensive, they have a very good reputation. The Department of Sanitary Engineering is also responsible for education of the students in the long-term courses. In these year, the number of such students is around 5.

## Future prospects

The Japanese Central Government currently decided to relocate many governmental offices and institutions including the IPH outside of Tokyo in order to decentralize the governmental functions densely accumulated in it. At this chance, we are going to expand the facilities for research, development and training in water supply and environmental sanitation. The Department of Sanitary Engineering proposes such new facilities as listed in TABLE 5.

TABLE 4 SUBJECTS OF GROUP STUDY IN 1988

| |
|---|
| Water Quality Management and Engineering Course |
| 1. Basic study for preparation of a manaual on the countermeasures for groundwater qualitity conservation |
| 2. Technologies for nitrate removal from drinking water |
| 3. Treatment efficiency of collective nigth-soil treatment plants based on the performance evaluation reports |
| 4. Effectiveness of polyelectrolytes in removing dissolved organic matter |
| 5. Utilization of a biological activated carbon filter for water purification |
| 6. Activated carbon adsorption of micro-organic contaminants under existence of humic substances |
| 7. Assessment technique for asbesto-cement pipe deterioration |
| Solid Waste Management Course |
| 1. Consensus formation in planning a solid waste treatment facility |
| 2. Study on proper management of solid wastes |
| 3. Study on medical waste management |
| 4. Monitoring strategy of groundwater contamination around a landfill site |
| 5. Some problems concerning construction waste management |
| 6. Technologies for nitrogen removal by small/medium-sized household wastewater treatment tanks |
| 7. Study on utilization of a post landfill site |
| 8. Proper management of sludges from individual household wastewater treatment tanks |

It is approved by the central government that the Department of Sanitary Engineering will have a new position of senior researcher whose task is specialized in research, development and training of appropriate technologies for developing countries. The Department has long experiences in international cooperation, and it is going to further strengthen such activities. The National Waterworks Technology Training Institute(NWTTI) in Thailand was established by collaboration of the Department, IPH, under the sponsorship of of Japan International Cooperation Agency(JICA). The Department has also started to closely collaborate with the Indonesian Government for establishment of the Water Supply and Environmental Sanitation Training Center.

TABLE 5 NEW FACILITIES PROPOSED FOR RESEARCH, DEVELOPMENT AND TRAINING BY THE DEPARTMENT OF SANITARY ENGIENEERING, IPH

Supply and domestic Waste water treatment

1. Model plant of water purification
2. Test plant of materials and equipment used for water supply
3. Model plant of collective nigth-soil treatment
4. Model plant of individual household wastewater treatment
5. Facility for bench-scale examination
6. Laboratory for physico-chemical analysis
7. Laboratory for instrumental analysis
8. Laboratory for bio-technology experiment
9. Laboratory for microbiological analysis
10. Laboratory for algae control experiment

Solid waste management

1. Facility for phisco-chemical treatment
2. Model plant of biological treatment
3. Labotatory for instrumental analysis
4. Model plant of thermal treatment
5. Sample bank
6. Laboratory for phisco-chemical analysis

## CONCLUSION

The history ofmanpower development in water supply and environmental sanitation sectors in Japan was reviewed with focusing on the activities of the Institute of Public Health. The most important points in education and training in relevant sectors may be summarized as follows:

1. It is desirable, especially in developing countries, that the national government will establish an institution for research and training where high-leveled education for personnels in water supply and environmental sanitation sectors can be expected.
2. A multi-disciplinary approach including the aspects of public and environmental health is necessary for education in the center as written above.
3. Practical training rather than theoretical training is indispensable for personnels in active service.

# LARGE WATER SUPPLIES IN CITIES AND SMALL WATER SUPPLIES IN RURAL AREAS

## - HOW DID SMALL WATER SUPPLIES EXPAND IN RURAL AREA RAPIDLY ? -

Mr. Hiroyuki ISHITOBI

Deputy Director, Water Supply Division,
Water Supply and Environmental Sanitation Department,
Ministry of Health and Welfare
Government of Japan

COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR
Jakarta, 27 - 28 February 1989

# Large Water Supplies in cities and Small Water Supplies in rural areas
## —— How did Small Water Supplies expand in rural area rapidly?

Hiroyuki ISHITOBI

## 1. Changes in Large Water Supplies and Small Water Supplies

### (1) The Number of Water Supplies (Table-1, Figure-1)

As of the end of 1984 in Japan, there were 96 Bulk Water Supplies, 1,924 Large Water Supplies, 11,440 Small Water Supplies, and 4,159 Private Water Supplies, totaling 17,619 water supplies, which supplied water to 93% of the population.

The number of water supplies had increased rapidly since 1950. Especially the increase of Small Water Supplies from 1950 to 1965 is remarkable.

However, the number of Small Water Supplies has been decreasing because severl systems are united into one, or a Small Supply is merged into Large Supply.

### (2) Population served by Water Supply (Table-2)

The first modern water supply was installed in Yokohama in 1887, and water supplies have been gradually expanded throughout the country since then. The percentage of all households supplied with water did not increase much in the early stages, and it took as many as 70 years to reach 40%. In the 1960s, however, the tempo began to quicken, and the level reached 80% in only 13 years.

The purpose of constructing water supplies in the early days was for prevention of epidemics such as cholera and for firefighting.

(3) Supplied Water (Table-3)

Economic development and rising of living standards have brought about increasing water demand , which should be supplied by waterworks.

Table-1 Changes in number of water supply

| Fiscal Year | Large-scale water supply | Small-scale water supply | Private water supply | Bulk water supply | Total |
|---|---|---|---|---|---|
| 1890 | 4 | 1 | 0 | | 5 |
| 1895 | 5 | 1 | 1 | | 7 |
| 1900 | 7 | 1 | 2 | | 10 |
| 1905 | 9 | 6 | 6 | | 21 |
| 1910 | 20 | 9 | 16 | | 45 |
| 1915 | 38 | 16 | 41 | | 95 |
| 1920 | 51 | 34 | 75 | | 160 |
| 1925 | 106 | 117 | 101 | | 324 |
| 1930 | 198 | 328 | 174 | | 700 |
| 1935 | 277 | 463 | 278 | | 1,018 |
| 1940 | 339 | 547 | 428 | | 1,314 |
| 1945 | 357 | 571 | 545 | | 1,473 |
| 1950 | 383 | 756 | 739 | | 1,878 |
| 1955 | 485 | 3,453 | 1,154 | | 5,092 |
| 1960 | 820 | 10,783 | 2,564 | | 14,167 |
| 1965 | 1,416 | 14,131 | 3,283 | 15 | 18,845 |
| 1970 | 1,662 | 14,021 | 3,646 | 35 | 19,364 |
| 1975 | 1,828 | 13,219 | 3,921 | 71 | 19,039 |
| 1980 | 1,896 | 12,148 | 4,128 | 85 | 18,257 |
| 1985 | 1,924 | 11,440 | 4,159 | 96 | 17,619 |

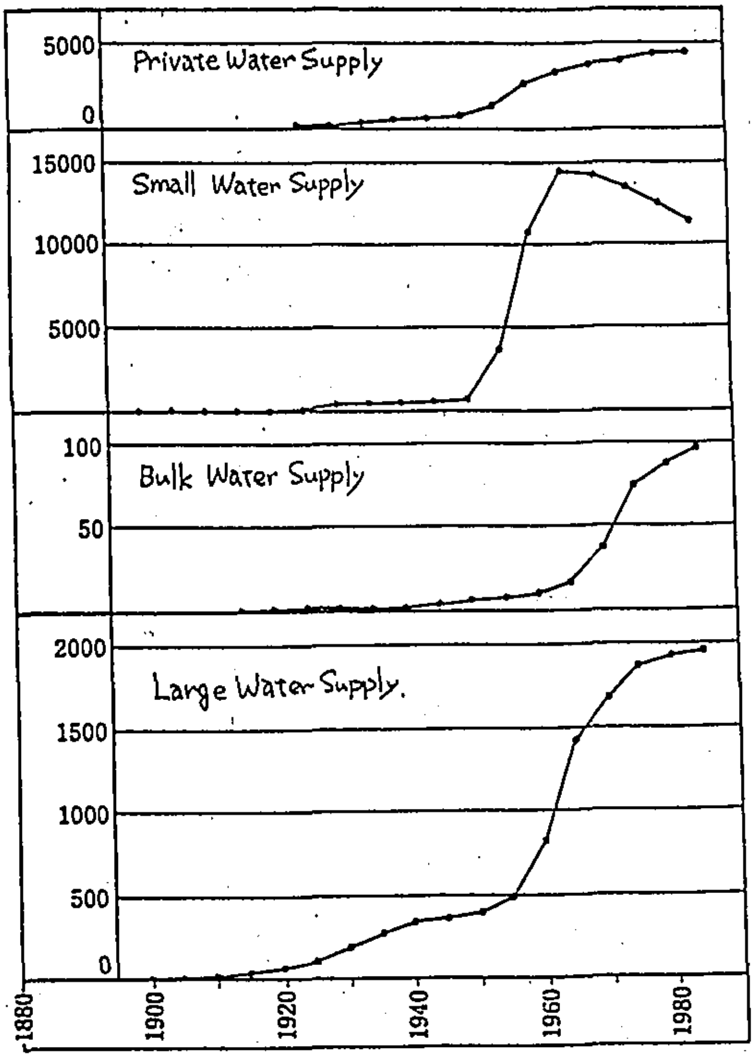



Figure-1 Changes in number of water supply

Table-2 Changes in the percentage of population served rate of water supply

| Year | Total population | Water system population served | Population served rate (%) | Small-scale water system population served | Population served rate (%) | Private water system population served | Population served rate (%) | Total population served | Population served rate (%) |
|---|---|---|---|---|---|---|---|---|---|
| 1890 | 39,902,000 | 193,250 | 0.5 | 450 | 0.0 | | | 193,700 | 0.5 |
| 1895 | 41,557,000 | 803,250 | 1.9 | 450 | 0.0 | | | 803,700 | 1.9 |
| 1900 | 43,847,000 | 1,017,350 | 2.3 | 450 | 0.0 | | | 1,017,800 | 2.3 |
| 1905 | 46,620,000 | 1,699,350 | 3.6 | 6,145 | 0.0 | | | 1,705,495 | 3.7 |
| 1910 | 49,184,000 | 2,131,322 | 4.3 | 12,485 | 0.0 | | | 2,143,807 | 4.4 |
| 1915 | 52,752,000 | 7,191,822 | 13.6 | 20,855 | 0.0 | | | 7,212,677 | 13.7 |
| 1920 | 55,391,000 | 9,758,822 | 17.6 | 43,176 | 0.1 | | | 9,801,998 | 17.7 |
| 1925 | 59,179,000 | 12,255,932 | 20.7 | 109,148 | 0.2 | | | 12,365,080 | 20.9 |
| 1930 | 63,872,000 | 14,976,055 | 23.4 | 257,925 | 0.4 | | | 15,233,980 | 23.9 |
| 1935 | 68,662,000 | 19,969,896 | 29.1 | 371,709 | 0.5 | | | 20,341,605 | 29.6 |
| 1940 | 71,400,000 | 24,150,243 | 33.8 | 443,966 | 0.6 | | | 24,594,209 | 34.4 |
| 1945 | 72,200,000 | 25,110,493 | 34.8 | 467,925 | 0.6 | | | 25,578,418 | 35.4 |
| 1950 | 83,200,000 | 26,087,184 | 31.4 | 613,741 | 0.7 | | | 26,700,925 | 32.1 |
| 1955 | 89,276,000 | 28,609,009 | 32.0 | 3,395,760 | 3.8 | | | 32,004,769 | 35.8 |
| 1960 | 93,419,000 | 37,831,566 | 40.5 | 9,704,373 | 10.4 | | | 47,535,939 | 50.9 |
| 1965 | 98,275,000 | 56,421,748 | 57.4 | 9,277,373 | 9.4 | 2,542,660 | 2.6 | 68,241,781 | 69.4 |
| 1970 | 103,720,000 | 72,361,443 | 69.8 | 9,118,507 | 8.8 | 2,274,044 | 2.2 | 83,753,994 | 80.8 |
| 1975 | 112,279,000 | 88,065,208 | 78.4 | 8,646,044 | 7.7 | 1,685,858 | 1.5 | 98,397,110 | 87.6 |
| 1980 | 116,860,000 | 97,620,403 | 83.5 | 8,180,528 | 7.0 | 1,112,661 | 1.0 | 106,913,592 | 91.5 |
| 1985 | 120,172,000 | 102,968,839 | 85.7 | 7,908,125 | 6.6 | 957,314 | 0.8 | 111,834,278 | 93.1 |

Table-3 Changes in ammount of supplied water

| Fiscal Year | Annual supply of water (x10³m³) | Population served x10³ | Average daily supply (m³) | Average daily supply per capita (ℓ/day) |
|---|---|---|---|---|
| 1890 | 6,446 | 194 | 17,660 | 91 |
| 1895 | 25,178 | 804 | 68,981 | 85 |
| 1900 | 32,466 | 1,018 | 88,948 | 87 |
| 1905 | 65,438 | 1,705 | 179,282 | 105 |
| 1910 | 98,128 | 2,144 | 268,844 | 125 |
| 1915 | 358,158 | 7,213 | 981,255 | 136 |
| 1920 | 510,512 | 9,802 | 1,398,663 | 142 |
| 1925 | 670,487 | 12,365 | 1,836,951 | 148 |
| 1930 | 1,004,608 | 15,234 | 2,752,351 | 180 |
| 1935 | 1,435,520 | 20,342 | 3,932,932 | 193 |
| 1940 | 1,926,274 | 24,594 | 5,277,463 | 214 |
| 1945 | 2,131,426 | 25,578 | 5,839,523 | 228 |
| 1950 | 2,310,678 | 26,701 | 6,330,625 | 237 |
| 1955 | 3,072,396 | 32,005 | 8,417,523 | 263 |
| 1960 | 5,105,269 | 47,536 | 13,987,038 | 294 |
| 1965 | 6,688,324 | 68,242 | 18,324,175 | 268 |
| 1970 | 10,088,629 | 83,754 | 27,640,079 | 330 |
| 1975 | 12,872,500 | 98,397 | 35,020,548 | 355 |
| 1980 | 13,666,223 | 106,914 | 37,441,707 | 350 |
| 1985 | 15,148,555 | 112,866 | 41,502,890 | 368 |

2. Main reasons of development of Small Water Supplies in rural area

2-1 Establishment of some institutions

(1) Legislation

① Drinking Water Caution Act : enacted in 1878

To keep wells clean and preventing from pollution to secure sanitary condition of water sauces

② Water Works Ordinance (old Water Works Law)

- Water works must be managed by municipal government.
- Water works must get approval from the Minister for Home Affairs prior to construction. etc.

3rd rivision of the ordinance in 1921

The Minister delegated a part of competence to the prefectural governor.

③ Water Works Law : enacted in 1957

- Water works should be managed by municipal government in priciple.
- Water works must get approval from the Minister for Health and Welfare prior to construction.
- Classification of Water Supplies
- Strengthening water quality control and facilities management
- Legislation of governmental subsidy system. etc.

(2) Financial Assistance

① Governmental Subsidy System

Gov. subsidy system for Large Water Supplies started in 1888. And, the system for Small Supplies (population served : not more than 5,000) started in 1952 (subsidy rate : 1/4). In the next year 1953, the subsidy system for Small Supplies in island started (subsidy rate : 35/100).

Since then, the system has improved as follows.

- subsidy rate was raised 1/4 → 1/4, 1/3, or 4/10 according to financial condition of municipal gov.

- Expansion of kinds of subsidized works
- Relaxation of several subsidy condition

② Local Bond System

Local bond system for Small Water Supplies started in 1957 (amount of bond : 2 billion yen, appropriation rate : 50%).

Since then, the system has been improved step by step (appropriation rate was raised 50% → 60% → 65% → 75%(1965) → 90%(1975))

Government approved the transfer from general account to special account of Small Water Supply in Local Financial Plan of 1966 (total 200 million yen).

The grant from national gov. to local gov. started in 1969.

(3) Administrative Organization

1886~ : Ministry of Home Affairs was responsible for all aspect of water supply

1938~ : Ministry of Home Affairs was responsible for construction of water supply
Ministry of Health and Welfare was responsible for sanitary aspect of water supply

1957~ : All aspect of administration about water supply was united to Ministry of Health and Welfare.

(4) Master Plan for Water Supply in Japan

1957 : 10-years Plan for Installation of Water Supplies
Goal; Percentage of population served would be 90% in 1967

1960 : New 10-years Plan for Development of Water Supplies
Goal; Percentage would be 81% in 1970, and construction cost would be estimated at 488 billion yen.

1962 : 5-years Emergency Plan for Development of Water Supplies

1970 : Master Plan for promotion of health and welfare administration

Goal; Percentage would be 92% in 1975

(5) Establishment of Design Criteria

1955 : Design Criteria mainly for Large Water Supply

1966 : 1st rivision of the Criteria

1977 : 2nd rivision of the Criteria

Design Criteria partidcularly for Small Water Supply was issued in 1969

(6) Training of Engineer

① Training course by the Institute of Public Health

② New department or course on water supply system were established in several universities and colleges

2-2 Participation of Inhabitants

Water supply in rural areas have promoted since 1950's. In 1952, governmental subsidiary system for small scale water works was established. Since then, construction of small scall water supply has accelerated in rural areas in Japan.

At that time, the subsidy rate was 1/4 .
The rest was covered by national loan and own fund.
The share of loan was about 50%~60% of the total construction cost. So, 15%~25% had to depend on the own fund.
In small villages and towns, it's very difficult to prepare own fund by themselves because of their weak financial basis.
So, the own fund was often prepared by the inhabitant themselves of the rural areas who want water supply system to get safe domestic water.
At that time, one of the most important matters was how to prepare the own fund.
In some villages, some campains to prepare own fund

required for the construction of water supply system was started.
People saves money under the slogan
"For construction of water supply system"
One of such campaigns was called as
"Egg savings-accont campaign", or
"Saving-accout campaign for his dearest wife"
Egg savings means that people in rural areas who raise hen save some eggs evry day to prepare money necessary for the resources of constructing water supply system. Such campaign extended almost all corner of Japan and the spread of water supply system was promoted nationwidely.

The examples of participation

① Discussion between local government and inhabitants in planning stage
② Cooperation in questionnaire on necessity of water supply (distributing and collecting questionnaires)
③ Demonstration to demand the promotion of construction of water supplies to the government, the members of Diet etc.
④ Savings campaign to bear the expense for constructing water supply
⑤ Offering place and money
⑥ Labor service (in excavation and backfill to install pipes)
⑦ Cooperation in management (cleaning wells and aroud them, inspecting)

## 2-3 Sanitary Education

(1) Public Relations (P.R.) of Water Supplies as Sanitary Facilities

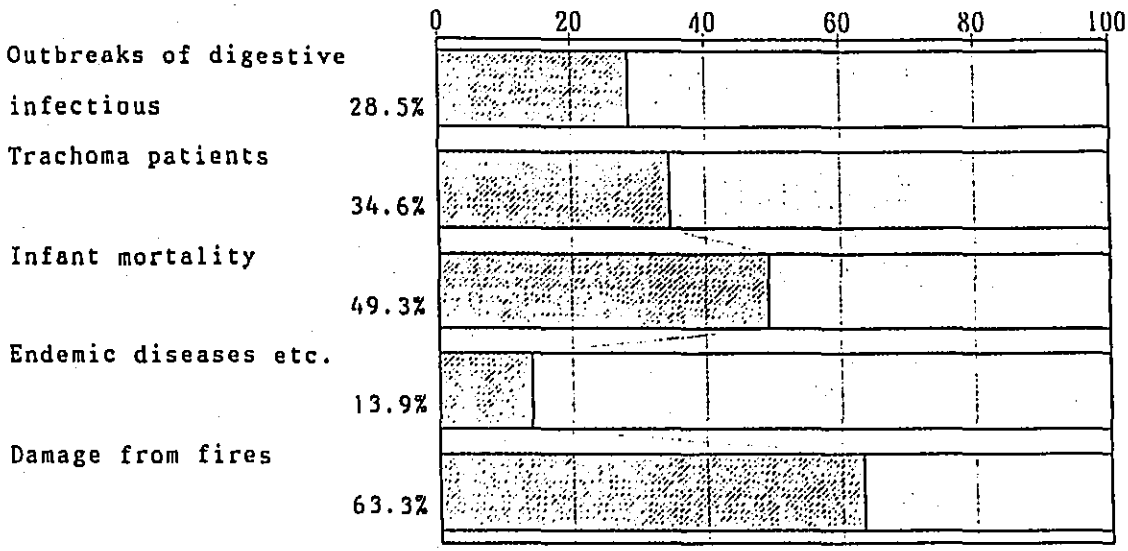
• Comparison Water Supply with Home electoric Pump (1959)

| | Home Pump | Water Supply |
|---|---|---|
| Cost of Construction | 60,000yen | 4,000～ 6,000yen |
| Cost of Maintenance (monthly) | 400yen | 200～ 300yen |
| Sanitary Condition | not always good | very good |

• Insisting on the sanitary effect by constructing wator supply

Figure-2 Effect of waterworks construction

( When the situation before supplied water is 100% ) (%)




(2) P.R. of Water Supplies as Improving Living Condition

- Release from drawing water
- Effective use of saved time
- Improvement of kitchen and bathroom

(3) P.R. with movie-films

- Comparison water supplies with private wells
- Explanation of how water supplies are installed

(4) The Events on "the Water Works Week" (1～7,June, every year)

- Distributing various kinds of pamphlet, poster concerning about water supply
- Contest for essay, slogan, picture
- Simposium
- Study and observation tour through the facilities of water supply

(5) Guidance concerning about Water Quality

- Keep wells and around them clean
- Necessity of disinfection with chlorine
- Appropriate way of using tap water
- Using water quality inspection car

(6) Education for Operator

- Improvement of knowledge necessary for operating facilities

## 2-4 Private Activity

(1) Establishment of Small Water Supply Association

① To request to promote of constructing of water supplies and to secure enough finances for constructing

② To be entrusted with making plan for constructing and design by municipal government

③ To hold the training and studying course for those who are engaged in management and maintenance of Small Water Supply facilities

(2) Development of Manufacturer of materials and Constructor

(3) Development of Technical Consultant (1950~ )

To be entrusted with making plan, design, and also supervising construction

Figure-3 Woman drawing water

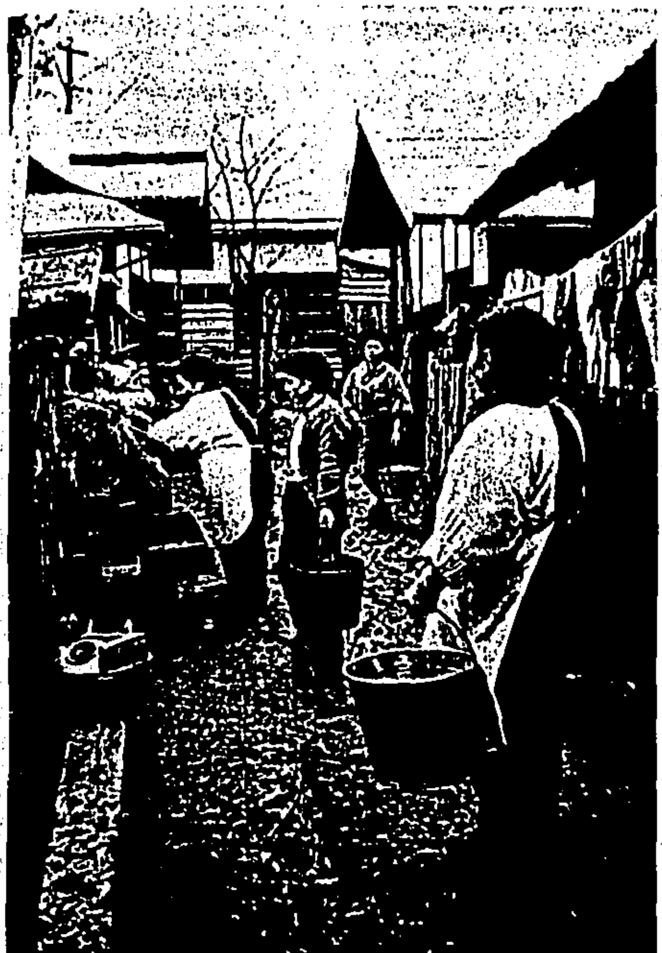


Figure-4. Women waiting the turn to draw water (1954)

Figure-5 Woman carrying water ([illegible])
in island

Figure-6 Draw Well ([illegible])

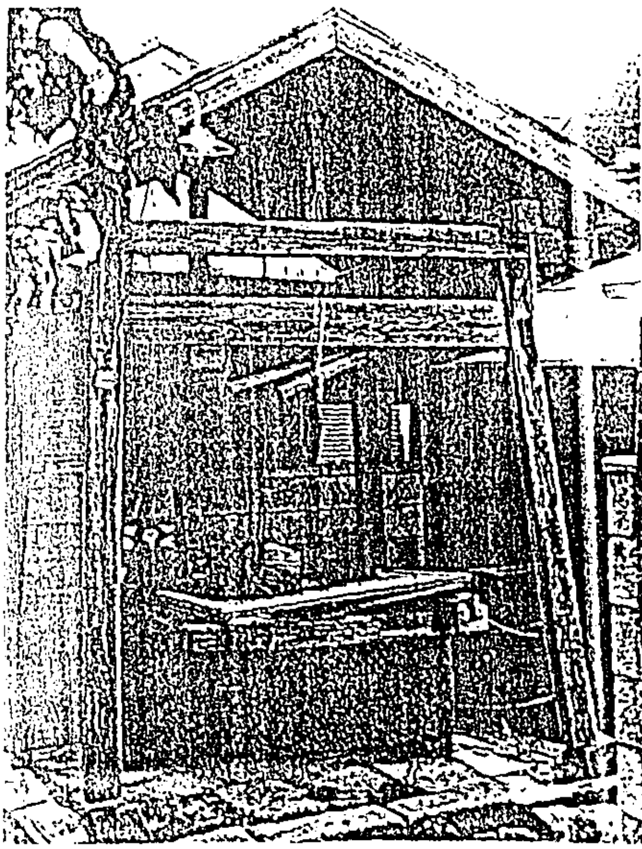
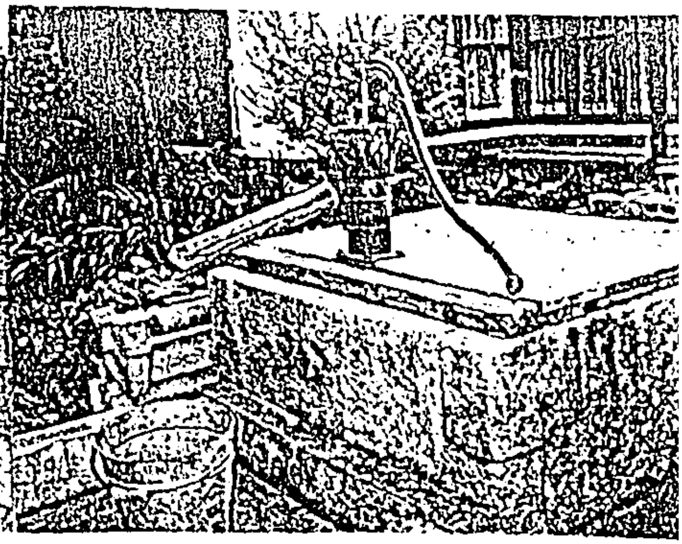


Figure [illegible] Well and Hand Pump
(193[illegible])



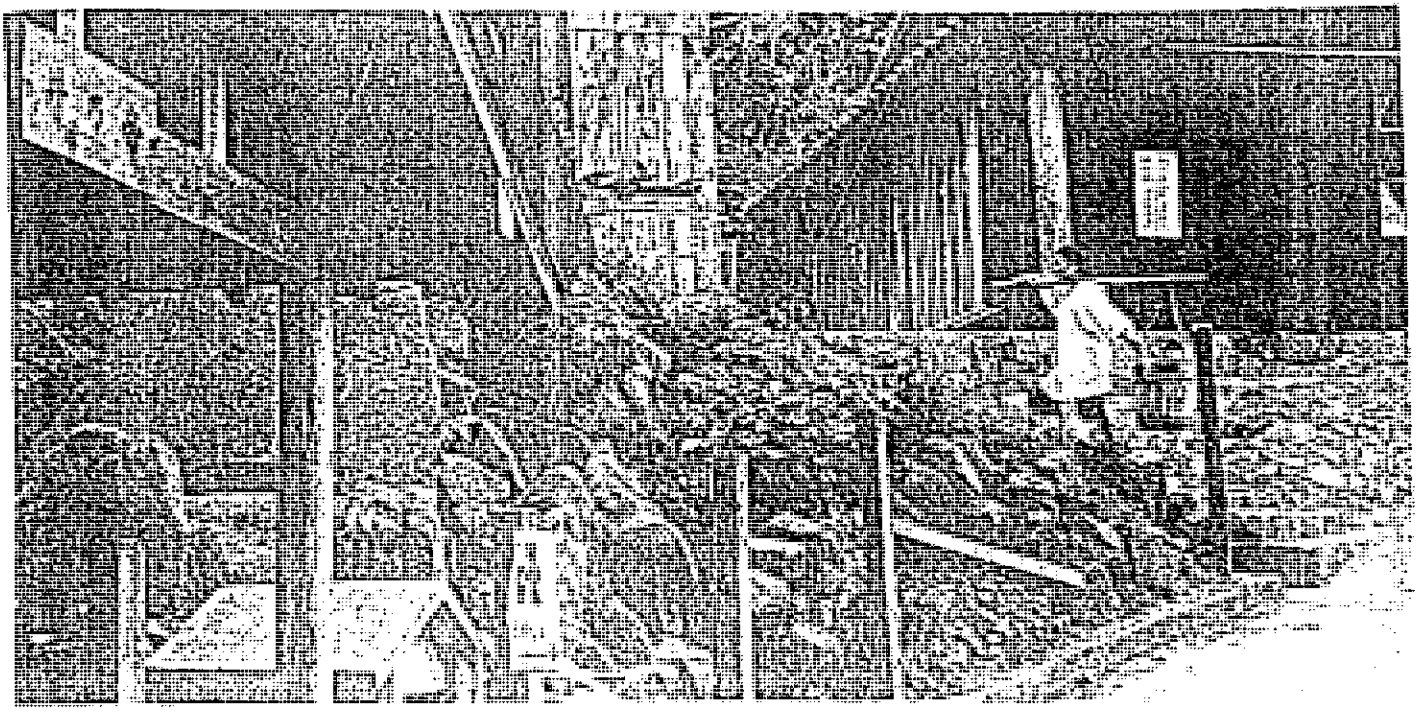


Figure-8 Woman carrying water (1953)

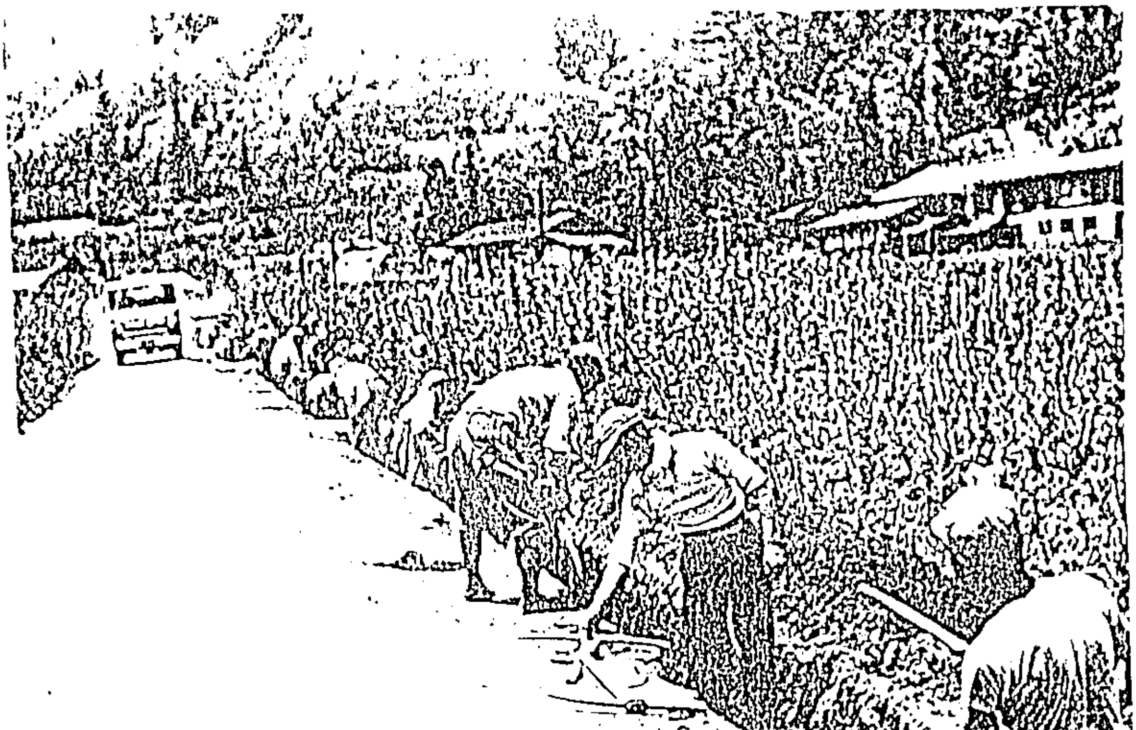


Figure-9 Labor Service

Figure-10 Women using public hydrant (1929)

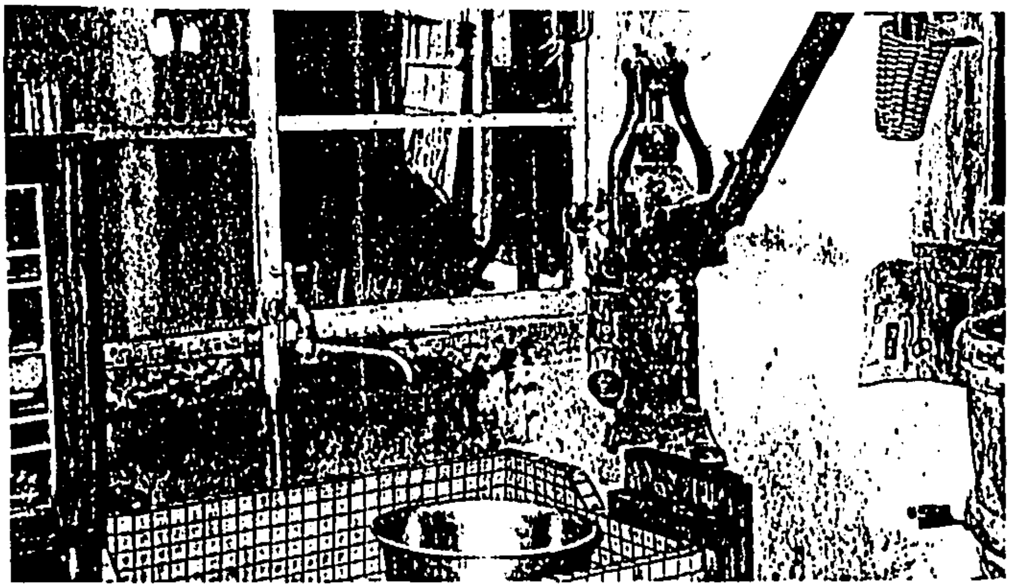


Figure-11 Faucet and Hand Pump. in kitchen

Figure-12. Training Course of pipe laying
held by Small Water Supply Association

# OUTLINE OF THE COLLECTIVE NIGHT SOIL TREATMENT SYSTEM DEVELOPED IN JAPAN

Dr. Yoshitaka MATSUO

Assistant Professor, Dept. of Civil Engineering,
Faculty of Science and Engineering,
Chuo University

COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS, MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR

# OUTLINE OF THE COLLECTIVE NIGHT SOIL TREATMENT SYSTEM DEVELOPED IN JAPAN

Y. MATSUO

## 1. INTRODUCTION

Japan is a country where construction of modern sewerage systems is yet under way. The population currently served with the sewerage system is estimated to be only forty percent of the total population. However, water pollution is not so much serious in Japan at present. It owes partly to that night soil generated in the areas uncovered with sewerage is managed by a collective night soil treatment system.

The collective night soil treatment system was developed in postwar Japan to substitute for sewerage systems yet to be constructed. In the system, tank lorries with a vacuum pump take out night soil from storage pits of vault toilets and transport it to a treatment plant, and the night soil thus collected is treated in the plant to a degree enough to discharge to waterbodies.

This paper outlines the collective night soil treatment system for information of the people who are responsible for control of water pollution in Indonesia.

---

The manuscript is prepared to submit to Indonesia/Japan Joint Meeting on Water Supply and Wastes Management on 27-28 /2/1989 in Jakarta.

The author is assistant professor at Chuo University, Faculty of Sci.& Eng., Dept. of Civil Engineering, 1-13, Kasuga, Bunkyo-ku, Tokyo, 112, Japan. He is currently a member of a committee responsible for compiling the Guidelines of Structures of Night Soil Treatment Plants for the Ministry of Health and Welfare of Japan.

## 2. HISTORY OF NIGHT SOIL TREATMENT IN JAPAN

### ◇ Pre-History

In prewar Japan, night soil was extensively used as fertilizer, because livestock manure was scarce there. The farmers came to towns to purchase night soil and carried it out to apply to their fields. This system might be seen as an ideal recyclic use of wastes.

The land application, however, played an important role in the spread of intestinal diseases such as bacterial dysentery, typhoid fever and paratyphoid fever in prewar Japan. The microorganism causative of these epidemics are excreted from the patient only with feces, though Salmonella typhosa (the pathogen of typhoid fever) is contained also in urine of the patient. The land application therefore accelerated the spread of the pathogen to waterbodies through rainfall runoff. The patients of dysentery in prewar Japan numbered up to about 80,000 per year and those of typhoid to 50,000.

The Japanese of the prewar eras were tormented above all with nutritional deficiency and anaemia due to Ascaridea (intestinal roundworms). Eggs of the worm in night soil are inactive in the toilet pit, but they grow in the fields to be infectious. The land application therefore aided also the spread of the disease , ascariasis. In fear of ascariasis, the Japanese were conservative in eating fresh vegetables. The school children took drugs periodically to remove the worms from the intestine. Yet it was reported that more than eighty percent of the total population had eggs of Ascaridea in 1946.

The land application, however, had declined rapidly in the immediate five years after the World War. Several causes were involved in it.

First, the sanitary corps of the U.S. force stationed in Japan advised prohibition of agricultural use of night soil on hygienic reasons. Second, transport of night soil to farmland became expensive due to expansion of urban areas. Third, cheap synthetic fertilizer began to be circulated with the restoration of chemical industries. Farmers preferred the synthetic fertilizer to night soil, since the former is easy to handle with. Furthermore, farmers could sell the vegetables grown by it with higher prices because the people's desire for use of fresh

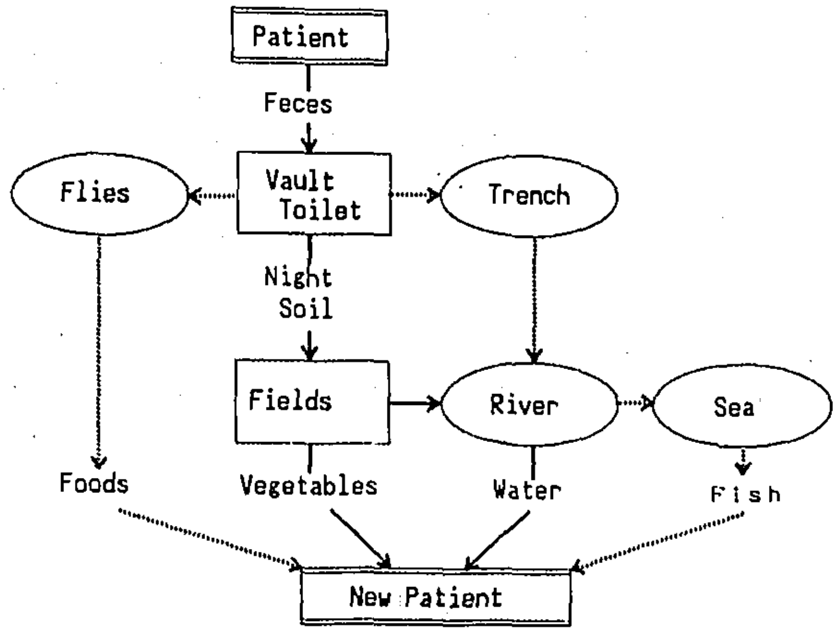



Fig. 1 Routes of Spread of Pathogens of Intestinal Diseases

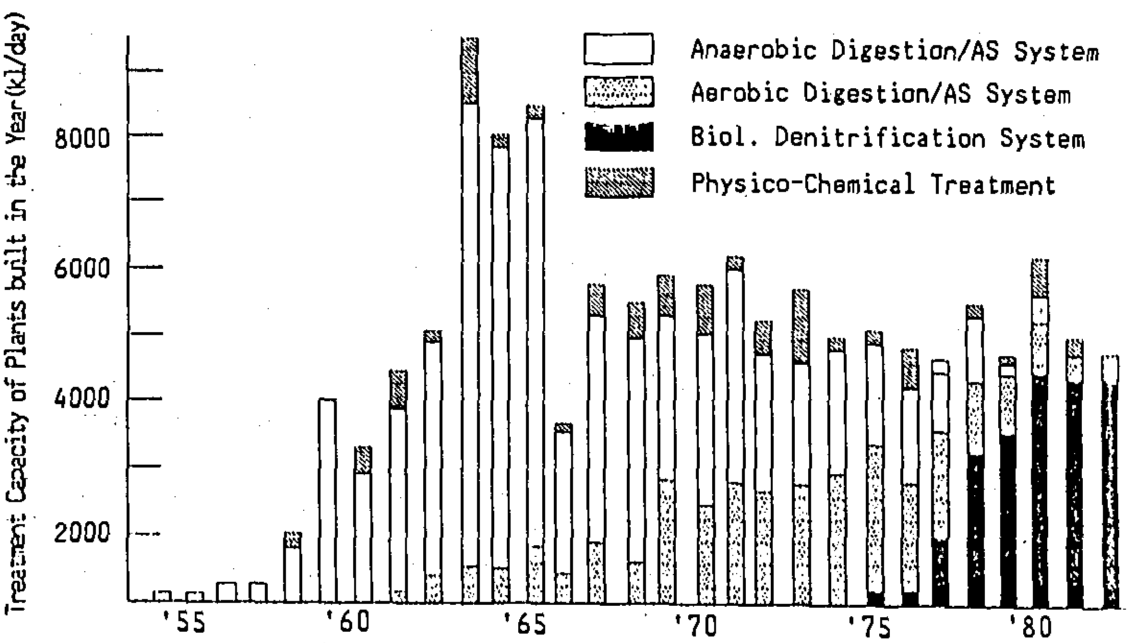



Fig. 2 Succession of Technology Used in Night Soil Treatment

vegetables in their diet was growing.

These facts discouraged farmers from using night soil as fertilizer. The people in towns consequently lost the sole route for disposal of their night soil, and night soil management emerged as a problem to be most urgently solved by municipal administration.

◇ Start of Night Soil Treatment

As a stopgap, many municipalities collected the night soil and dumped it to mountains, to rivers, and above all to seas. In the 1950s, fifteen cities dumped night soil to the inshore at the rate of 10,000 kl/day, which was equivalent to a population of seven to ten millions. The disposal of this manner, of course, brought about heavy pollution to the environment, and was bitterly criticized. The National Council On Night Soil Problems organized by the Japan Scientist Conference in 1954 submitted an appeal for stop of night soil injection to seas and pointed out the need of constructing treatment plants for collected night soil.

The government was ready to recognize the importance of the problem, and immediately started the studies on methods of night soil treatment. The Resource Survey Committee, which was commissioned to seek the methods appropriate for night soil treatment, submitted an official report in 1950. It recommended anaerobic digestion as the most promising method for night soil treatment as follows;

> " Having studied various physico-chemical treatment methods and biochemical treatment methods, this committee concludes that anaerobic digestion among the biological methods is most rational on scientific bases, most economic and resource-saving enough to spread it to all Japan as the treatment method of the night soil which is collected with lorries.
>
> Anaerobic digestion kills disease-causing microorganisms and destroys roundworms and their eggs by the toxic substances such as ammonia and phenols, which are produced in the course of degradation of organic matter in the night soil by the activities of anaerobic microorganisms.
>
> The method comprises an artificial acceleration of the

geochemical process by which various organic matter is converted to coal and natural gas. The method needs no resource other than facilities for proliferation of the anaerobic microorganisms. The method requires air tight tanks to hold night soil under anaerobic conditions, and the night soil must be warmed up to the temperatures appropriate to anaerobic microorganisms. However, the methane containing gas produced in the course of degradation of night soil can be used as the fuel for warming. The quantity of the gas required for warming is only two-third of that generated so that the excess one third can be supplied to other uses. "

Based on the recommendation, the government began to subsidize to the construction of anaerobic digesters since 1953. The Public Cleansing Law enacted in 1954 specified structures of the plants and degrees of the treatment. The First Five Years Plan of Night Soil Treatment was projected in 1956 by the Ministry of Health to institutionalize the subsidies to construction of night soil treatment plants. With these measures, the grand construction of collective night soil treatment plants was set out.

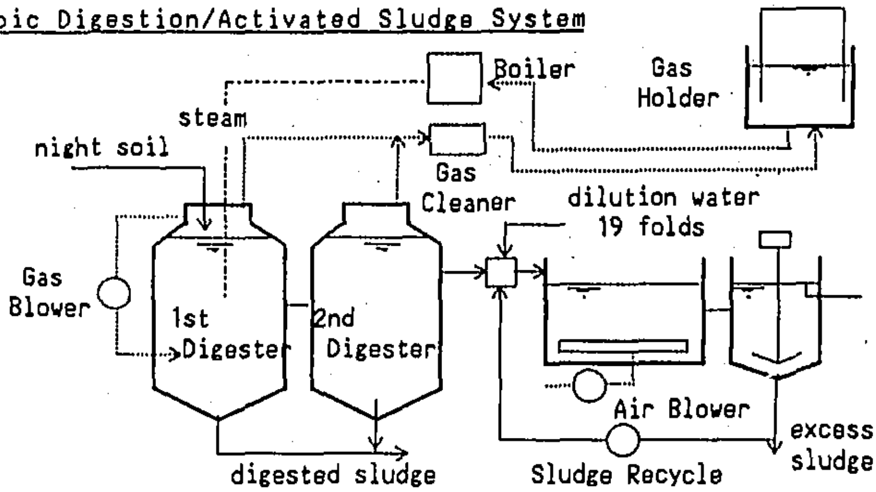
Up to the end of the Sixth Five Years (1981-1986), the number of the treatment plants constructed has incresed up to more than 1300. The total treatment capacity, in the volume of night soil to treat daily, amounts up to 110,000 kl per day, which is equivalent roughly to a service population of 80 millions. As the result, almost all Japanese have access to the service of the collective night soil treatment system now.

◇ Succesion of Treatment Technology

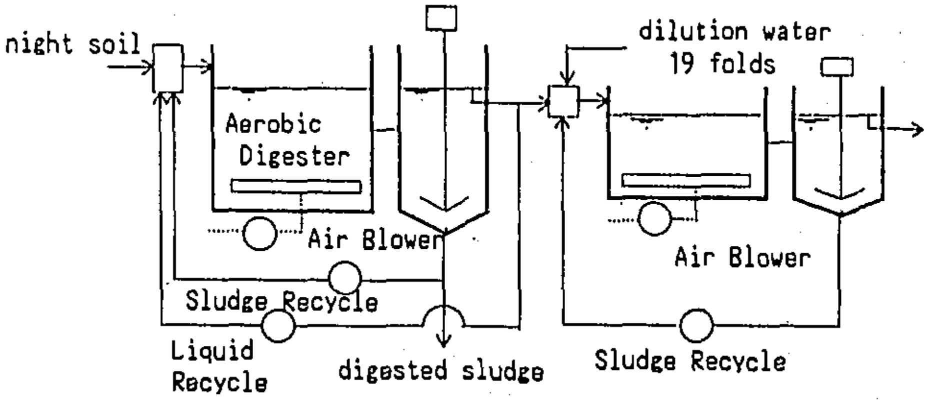
The treatment technology preailingly used in the plants has changed during the three decades. The main target of treatment in the first decade is sanitary disposal of the collected night soil, including supply of well-stabilized sanitary fertilizer to suburban farmers. The purpose was well achieved by the anaerobic digestion/activated sludge system, in which anaerobic digestion process is followed by activated sludge process.

The second ten years saw prevalence of the aerobic diges-

Anaerobic Digestion/Activated Sludge System




Aerobic Digestion/Activated Sludge System




Biological Denitrification System

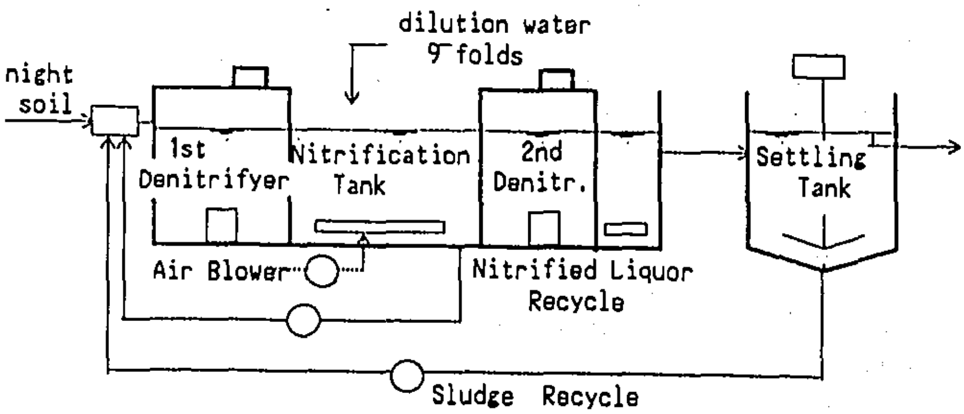



Fig. 3 Main Treatment Systems For Collective Night Soil Treatment Plants

tion/activated sludge system, in which aerobic digestion process is substituted for the anaerobic digestion process. The preference of this system was due to that it required less area for the plant site and less initial investment.

Japan of 1960s' saw a tremendous explosion of pollutional incidents. This resulted in the enactments of Basic Law of Environmental Pollution Control in 1967, and of Water Pollution Control Law in 1970. This trend effected on the night soil treatment management. Improvement in the effluent quality was demanded not only by the tightened legal regulations but also by the people neighboring on the treatment plants, and the target of the technical development was changed from " smaller and cheaper plants " to " better effluent ".

What was most strongly demanded by the neighboring people was visual improvement of the effluent. The color of the effluent from the conventional biological treatment process resembles to that of urine, even when the effluent is enough purified in the $BOD_5$ level. It was soon realized physico-chemical advanced treatment processes such as coagulation or ozonation was effective for removal of the color. But intensive studies revealed the nitrogenous compounds affected the performance of these processes. For example, a high alkalinity due to ammonium content exhausts chemicals in the coagulation by alum or by ferric compounds. Nitrites consume ozone prior removal of the color. For the efficient use of the advanced treatment processes, consequently, the biological denitrification system has been prevailingly used in night soil treatment since 1975.

## 3. CURRENT STATE OF NIGHT SOIL MANAGEMENT IN JAPAN

### ◇ Routes for Night Soil Disposal

The amount of organic pollutant generated in Japan is estimated to sum up to 5,500 tons/day as $BOD_5$, ninety two percent of which is to be domestic. According to a survey conducted by the Ministry of Construction, night soil constitutes 36 % of the total load of $BOD_5$ generated in households. The $BOD_5$ load of night soil therefore is one third of the total load generated in Japan. Night soil management, therefore, is a very important component of water pollution control.

The prewar Japanese used mostly a vault toilet with a storage pit. Currently, more than half of the population uses water flush toilets. Most of night soil deposited in vault toilets is managed by collective night soil treatment systems. For the flush toilets, and nearly half of them are connected to sewers and the wastewater from them are treated in the sewage treatment plants. The wastewater from another half of the flush toilets are treated privately owned treatment apparatuses.

Vault toilets are not so sanitary as flush toilets ; they smell and breed flies, and they decrease amenity of houses and towns. It is natural, therefore, people prefer a flush toilet to a vault toilet.

◇ Delayed Construction of Sewerage System

The combination of flush toilets and a public sewerage system is the best sanitation system from the viewpoints of house amenity and water pollution control. However, the people who have access to a public sewerage system are very limited in Japan. Sewerage service ratio (the ratio of population served by sewerage systems to the total population in a sewerage projected area) exceeds 80 % in densely inhabited cities such as Tokyo or Osaka. However, the national average currently exceeds just only 40 %, and the service ratios of cities smaller than 50,000 in population remain at less than five percent. The national average ratio of sewerage service is increasing at one percent per year or less. Construction of sewers in highly urbanized areas is a laborious and time consuming work. In many cases, burial of sewerage by open cut methods is obliged to be done in mid night to avoid traffic confusion. Otherwise, sewers are constructed by tunneling methods in which it takes more than three days to dick a tunnel length of ten meters. Even with the expenditure of a gross amount, therefore, it is difficult to accelerate the increase,

◇ Problems of Private Treatment

When a flush toilet is used in any area uncovered by sewerage systems, the household is demanded by laws to install privately an on-site apparatus for treatment of wastewater from the toilet. The apparatus is called purification tank in Japa-

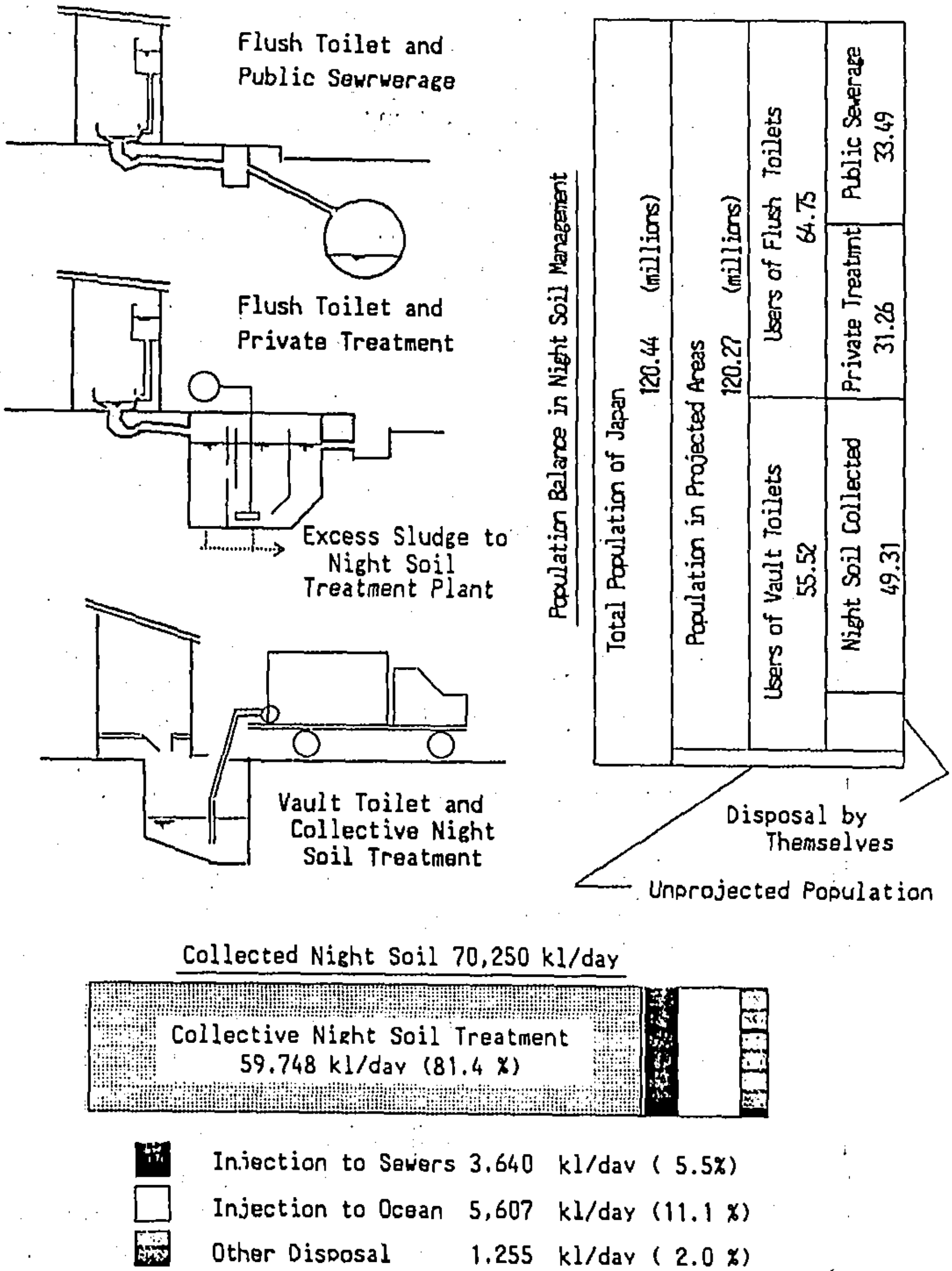



Fig. 4 Night Soil Management Systems in Japan at F.Y. 1984

nese. Most purification tanks are miniatures of an activated sludge plant or a submerged aerobic filter. The sludge produced in the purification tanks are managed by the collective night soil treatment system of the city.

The number of purification tanks is increasing year by year due to the delayed construction of the sewerage systems, and it is currently the most important subjebt of sanitary engineer in Japan to improve the performance of purification tanks.

The most used purification tanks are those of the smallest type (less than 20 persons) and they are legally under obligation to have performance of more than 65 % in $BOD_5$ removal. Due to the strong fluctuation of the wastewater volume and due to insufficient maintenance of the owners, their actual performance tends to be lower than the nominated performance. The spread of the purification tanks of a smaller size adversely effects on water pollution control.

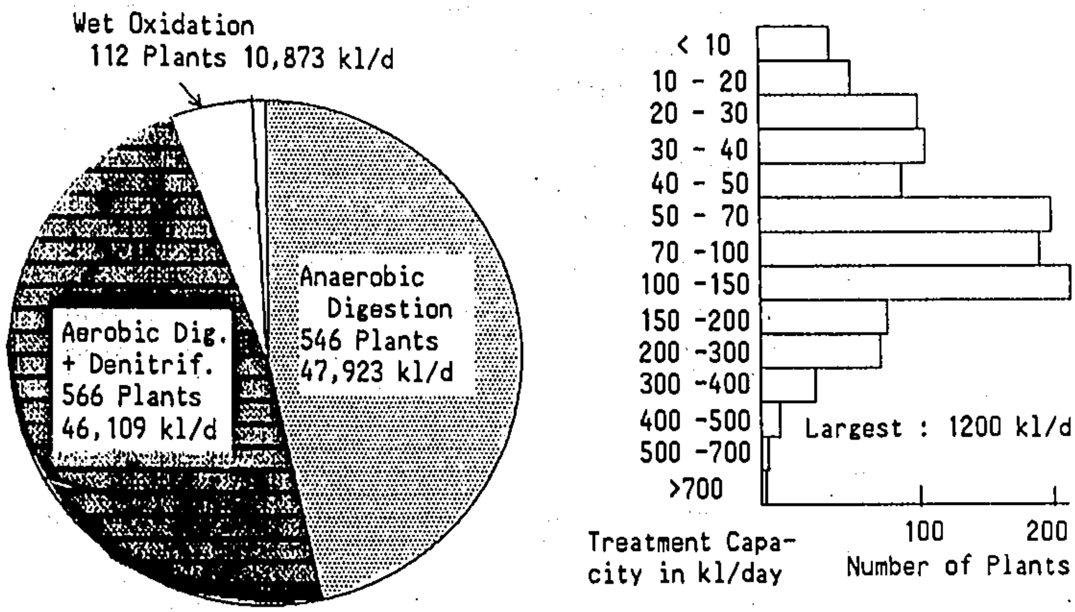
◇ Merits of Collective Night soil Treatment

The collective night soil treatment systems currently receive the night soil of one third of the total population along with the sludge from of the purification tanks owned by one fourth of the total population.

From a viewpoint of treatment engineering, combination of vault toilets and the collective night soil treatment system is preferred to the modern sewerage systems. The collected night soil is strongly polluted but small in volume. It does not fluctuate in quantity and quality so much as diluted sewage discharged from flush toilets. These characteristics make it possible to treat it very efficiently with moderate costs.

The initial investment of the collective night soil treatment plant is nearly ¥ 20,000 per head, and the treatment cost is about ¥ 4,000 per head per year. The average of the initial cost public sewerage systems, including storm sewers, amounts up to ¥ 240,000 per head and the treatment cost is ¥ 8,000 per head per year. The $BOD_5$ removal in the collective night soil treatments recently constructed exceeds 98 %, but that in sewage treatment is below 95 %.

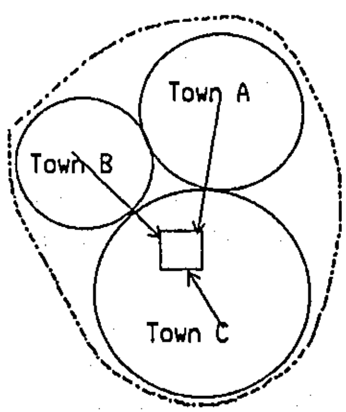
The collective night soil treatment system cannot receive all the domestic wastewater due to the high cost of transpor-




Distribution of Treatment Systems Emolved

Distribution of Treatment Capacity

Fig. 5 State of Night Soil Treatmet Plants in Japan in 1984




Small towns unite to manage a collectiv night soil treatment system

Fig. 6 Wide-area Sanitation Union

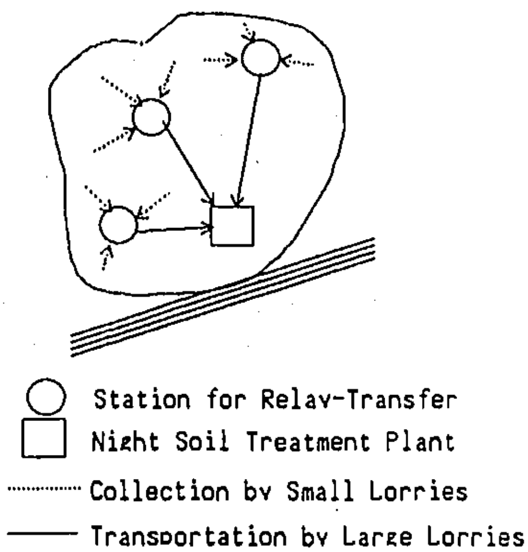



Fig. 7 Collection System Used by Large Municipalities

tation. However, it is advantageous over the public sewerage system in quickly improving urban sanitation and water pollution with moderate expenditure.

◇ Finance of Collective Night Soil Treatment Systems

Collective night soil treatment systems are administered directly by local municipalities or by public service corporations (Public Cleansing Unions) which are organized by municipalities for this purpose. Most large cities have the system by themselves, but smaller towns have it together with neighboring towns.

Construction of treatment plants is subsided by the government, but operation of the system including collection must be financed by municipalities themselves. Tank lorries are also out of the governmental subsidies. Most municipalities impose charges on the users of the system, and the income is used to make up the running cost.

Size of treatment plants widely varies ; larger ones treat night soil at the rate of more than 700 kl/day, which is roughly equivalent to a service population of 500,000, but smaller ones deal with night soil excreted by only 3,000 persons. The optimum size may be dependent on cost of treatment and that of collection. The treatment cost decreases with the plant size because of the lessened man power for operating the plant. The collection cost, on the contrary, tends to increase with the size, because larger plants need collection of wider areas.

Tank lorries used for the collection are varied in the container size from 2 to 10 cubic meters. Take out of night soil is easy with a smaller lorry because the roads are usually narrow in the residential area of Japanese cities and towns. Some cities installed relay-stations where the night soil taken out by smaller lorries is transferred to larger lorries to transport it to the treatment plant.

◇ Regulations on Effluent Quality

Pollution levels of the effluent from a night soil treatment plant is regulated by multiple laws.

First of all, quality of the effluent from any night soil treatment plant should meet the standards specified by Public

Cleansing Law. The law ordains the effluent pollution levels should be

less than 30 mg/L in $BOD_5$ ,

less than 70 mg/L in suspended solids and

less than 3000 cells/mL in most probable numbers of coliform bacteria.

Secondly, the effluent quality must satisfy the standards provided by various pollution control laws rooted in Water Pollution Control Law. It must meet the standards specified by water pollution control ordinances of the prefecture, which are usually more stringent regulations than those specified by Public Cleansing Law. When a plant is sited in the areas specified by Areawide Total Pollution Load Law, the load of COD (permanganate consumption value) from the plant is limited by the regulation based on the law. When the receiving waterbody is connected to any lake specified by Clean Lake Law, the contents of nitrogen and phosphorus in the effluent should satisfy the standards ordained by the law.

Construction of treatment plants is an enterprise of the municipality but the plan must be authorized by the prefecture governor as an enterprise based on City Planning Law, and by the Minister of Health and Welfare as an enterprise based on Public Cleansing Law. Both laws demand to get the consents to the construction of people in the neighborhood of the plant site. Furthermore, Public Cleansing Law institutionalizes also to get the agreements with fishermen and farmers using the waterbody which is planned to receive the effluent from the plant.

Everybody is ready to realize the collective night soil treatment plant is an installation indispensable for public sanitation and water pollution control. But nobody likes the plant to site in their neighborhood, because it handles with the worst wastewater. The people tend to demand to the municipality to install a plant of the best technology and to grade up the effluent quality as much as possible. This trend has become stronger since early 1970s.

The demands of the people to the effluent quality are usually more stringent than any legal regulations so that effluent quality designed in the construction plan is virtually determined by them in most cases.

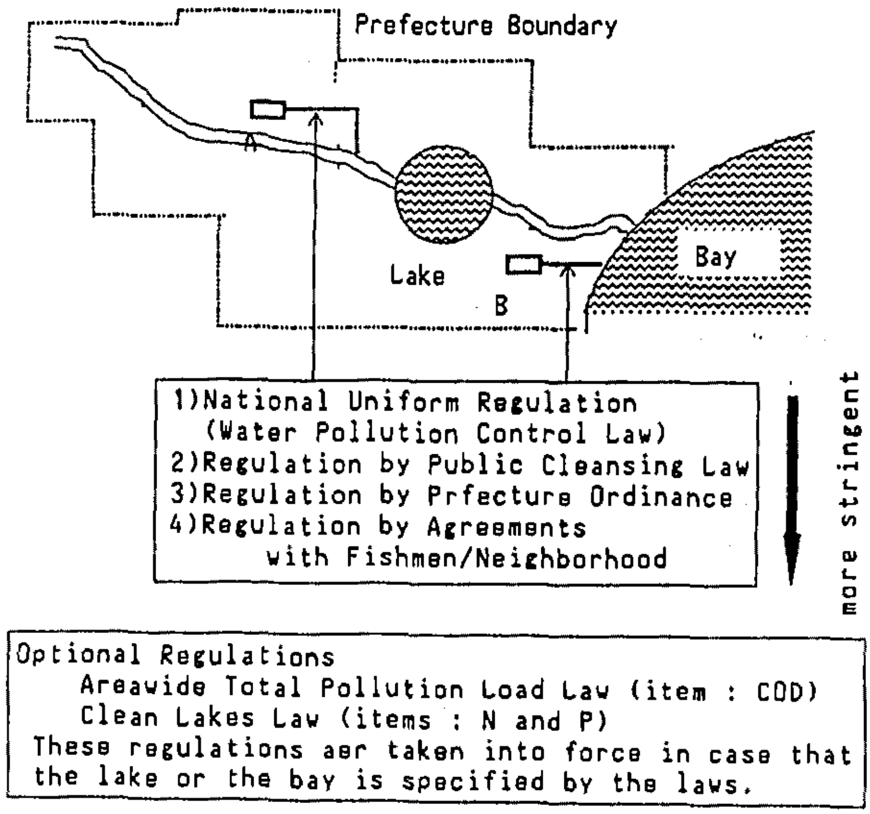



Fig. 8 Effluent Quality Regulations to
Collective Night Soil Treatment Plants

Table 1 Targets of Night Soil Treatment
--- Quality of Night Soil and Effluent Standards

| | Collected Night Soil | 20 folds Dilution | Official Regulation | Example of Agreement |
|---|---|---|---|---|
| p H | 7.0-8.5 | --- | 5.8-8.5 | --- |
| $BOD_5$ (mg/L) | 13,500 | 670 | < 30 | < 5 |
| S S (mg/L) | 21,000 | 1050 | < 70 | <10 |
| $COD_{Mn}$(mg/) | 9,000 | 450 | < 30 | <10 |
| T-N (mg/L) | 4,500 | 225 | --- | <10 |
| T-P (mg/L) | 600 | 30 | --- | < 1 |
| NCB (-/mL) | ---- | --- | <3000 | --- |
| Color | ---- | --- | --- | <20 |

$COD_{Mn}$ : oxygen demand determined from $KMnO_4$ consumption
NCB : most probable number of coliform bacteria
****** Night Soil generated is 1.0-1.4 kl/head *******

## 4. OUTLINE OF COLLECTIVE NIGHT SOIL TREATMENT

### ◇ Generalization

The principal object of the night soil treatment is removal of organic compounds and disease-causing organisms, although demand for removing nitrogen, phosphorus, and color together with is recently increasing.

Facilities of collective night soil treatment plants are composed of four components;

(1) reception and storage facilities
(2) main treatment facilities
(3) disinfection facilities
(4) sludge treatment facilities.

Any plant has similar facilities of all the components but the main treatment, and flow of the whole treatment process may be described as below.

*** Reception and Storage ***

Collected night soil is first processed in the reception and storage facilities. The night soil is discharged from lorry's containers to a receiving pit. Grits contaminated in the night soil is removed by gravity in the pit. Removal of grits is indispensable to keep pumps and other machinery used in treatment from injury. The night soil then commuted and screened to remove tissue stuff. The solids separated by the screen is dehydrated by a pressing machine and incinerated. The screened night soil enters to a storage basin large enough to equalize the rate of flow to the main treatment.

*** Main Treatment ***

In the main treatment facilities, the night soil is processed to remove pollutants such as $BOD_5$, suspended solids as well as to destroy organisms causative of diseases. Various technologies including chemical processes and thermal ones have been applied for the main treatment process in the past four decades, but prevailingly used are combinations of biological methods as follows;

(1) anaerobic digestion / activated sludge system
(2) aerobic digestion / activated sludge system

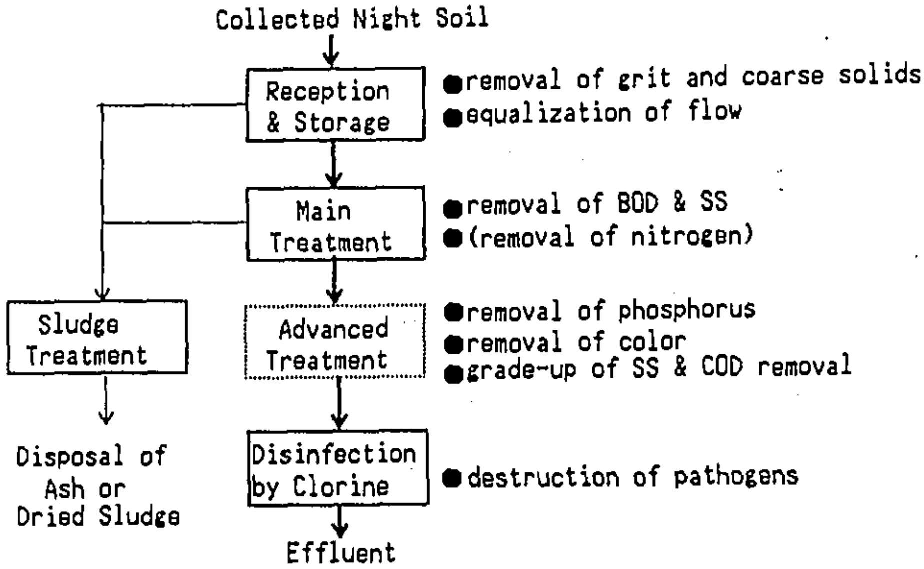
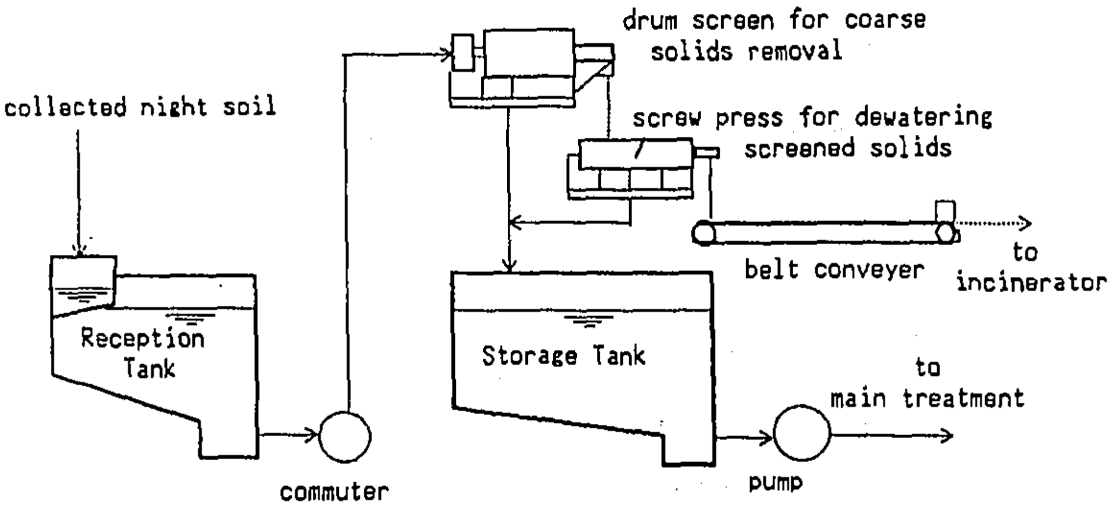



Fig. 9 Components of Collective Night Soil Treatment




Volume of Sorage Tank ; enough to hold night soil to treat in 2 days

Screned Coarse Solids ; 5-8 kg/kl night soil

Fig. 10 Outline of Reception and Storage Facilities

(3) biological denitrification system.

The Guidelines for Structures of Night Soil Treatment Plants compiled in 1988 specifies these three systems as standard treatment technologies.

Because night soil is too strong in ammonia concentration for activated sludge microorganisms to actively work, the first two systems are permitted to dilute the digested night soil up to twenty folds with river water or other water before entering the activated sludge process.

In the biological denitrification system, the ammonium is oxidized to nitrite or to nitrate by nitrifying microorganisms, and the oxidized nitrogenous compoulds, in turn, are reduced by denitrifying microorganisms into inert nitrogen gas. The toxic effect of ammonia therefore is not very prominent in the system, so that the system requires much less dilution water. In the usual practice, the night soil is ten folds diluted, but it is not rare to operate the system with dilution of less than three folds.

The configuration and the characteristics of the three systems will be described in the next section.

If the plant is sited in the area demanded to discharge effluent of a high quality, an advanced treatment system is added to the main system. The advanced treatment system is arranged by combining in series unit processes as follows.

(1) chemical coagulation

to remove phosphates and

to grade up removal of S.S and organic compounds

(2) sand filtration

to polish the suspended solids removal

(3) ozonation

to extinguish color

(4) activated carbon adsorption

to complete the removal of organic compounds.

Many recently installed plants include almost all of the unit processes above described, and even old plants tend to add at least the chemical coagulation process to the main treatment process. The chemicals used are alum or ferric compounds for main coagulants, and synthetic organic polymers for aiding coagulants.

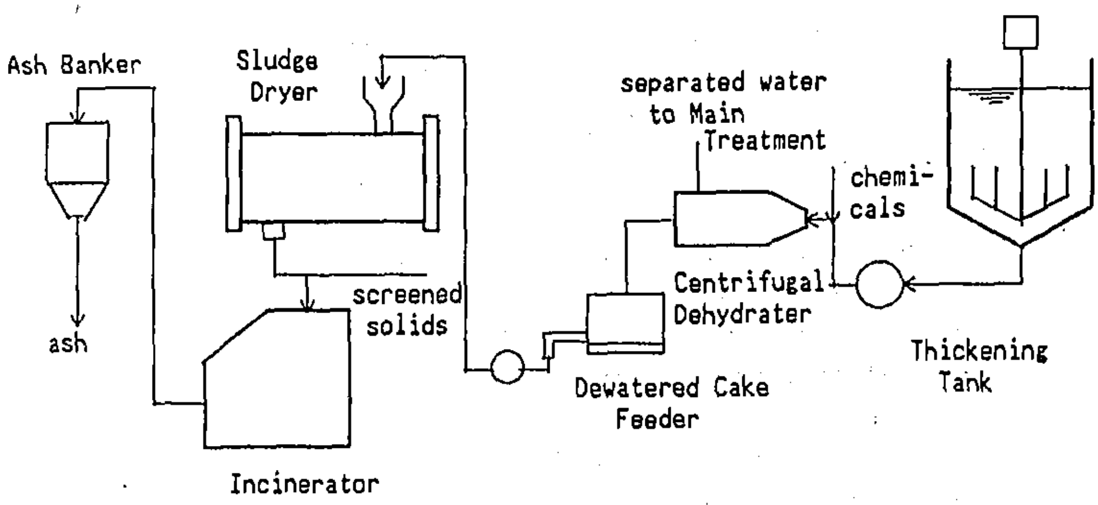



Fig. 11 Outline of Sludge Treatment Facilities

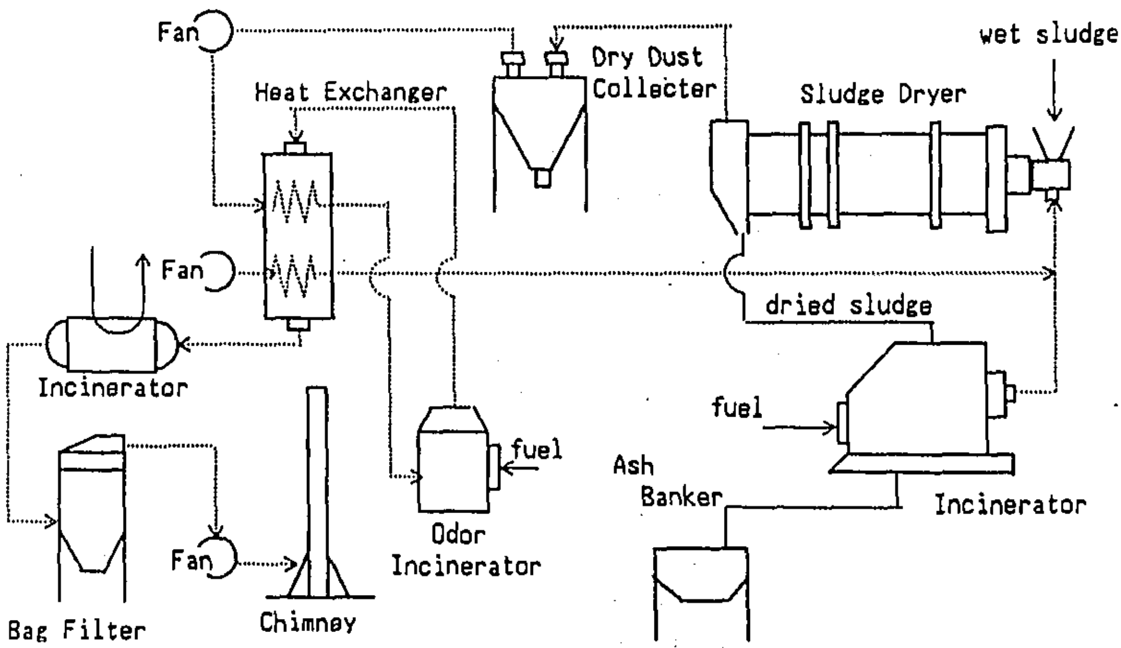



Fig.12 System For Drying and Incinertion of Dehydrated Sludge

*** Disinfection ***

The effluent from the main treatment process is chlorinated before discharge to waterbodies to ensure destruction of disease-causing organisms. The number of coliform bacteria is used as the indicator of the destruction. To avoid hazards in handling with chlorine gas, liquid sodium hypochlorites or solid calcium hypochlorites are used as the chlorine source. Dosage of 20 mg/L as chlorine is proved enough to maintain the number of coliform bacteria at less than 3,000 cells per milliliter.

*** Sludge Treatment***

The sludge produced in the treatment is treated in the sludge treatment process, which is usually composed of facilities for thickening, dehydration and incineration. The sludge from anaerobic digestion is well stabilized and sanitary enough to use as fertilizer. The sludge from the aerobic process or from the denitrification system, however, is not so stabilized that it needs to be matured by composting when it is applied to land.

◇ Technology Used in Main Treatment

*** Anaerobic Digestion / Activated Sludge System ***

This system uses anaerobic digestion as the principal treatment process and activated sludge process as the additional treatment process.

Anaerobic digestion or methane fermentation is a natural process of microbial consortium under the oxygen free condition, which converts various organic compounds into most reduced one carbon compounds (methane) and most oxidized one carbon compounds (carbon dioxide). It has been long used as a sludge stabilization method in sewage treatment plants, yet the process seems to have undeveloped usages.

The use of anaerobic digestion in night soil treatment began with the start of the history of collective night soil treatment systems as previously described. The plants built in the earliest period used trickling filters as the secondary treatment process, but they were soon replaced by activated sludge process.

In usual practice, anaerobic digestion is performed in two tanks. The first is stirred by circulation of generated gas

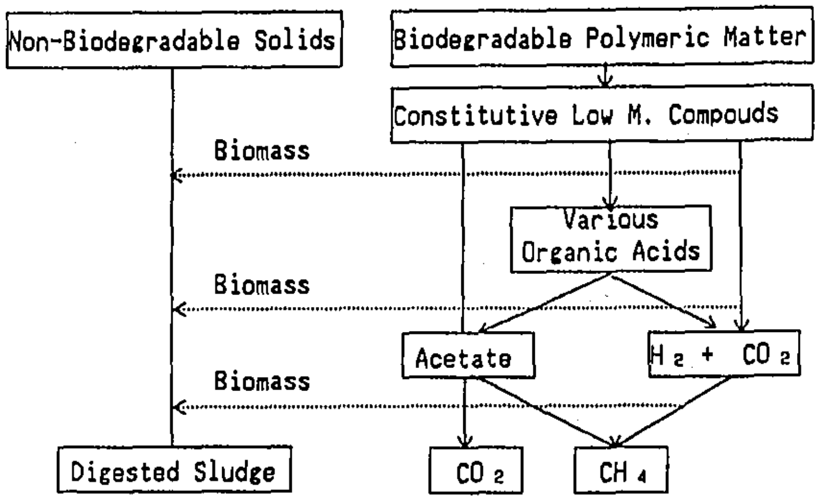



Fig. 13 Conversion of Organic Matter in Anaerobic Digestion

Table 2 Typical Performance of
Anaerobic Digestion/Activated Sludge System

| | Collected Night Soil | Digested Liquor | Final Effluent | Removal (%) |
|---|---|---|---|---|
| Dilution | 1.0 | 1.0 | 13 | --- |
| $BOD_5$ (mg/L) | 11,490 | 2270 | 48 | 93.8 |
| S S (mg/L) | ---- | 3180 | 39 | --- |
| $COD_{Mn}$(mg/) | ---- | 2790 | 86 | --- |
| $NH_4$-N (mg/) | ---- | 3790 | 134 | --- |

Table 3 Typical Performance of
Aerobic Digestion/Activated Sludge System

| | Collected Night Soil | Digested Liquor | Final Effluent | Removal (%) |
|---|---|---|---|---|
| Dilution | 1.0 | 1.0 | 20 | --- |
| $BOD_5$ (mg/L) | 11,490 | 2140 | 26 | 94.4 |
| S S (mg/L) | ---- | 4730 | 47 | --- |
| $COD_{Mn}$(mg/) | ---- | 2350 | 59 | --- |
| $NH_4$-N (mg/) | ---- | 1800 | 73 | --- |

(methane and carbon dioxid), and the second is unstirred. Raw night soil enters to the first tank, digestion or methanation takes place mostly there. The second tank is used for separation of settlable solids from the digested liquor from the first tank, and the settled solids were removed as digested sludge, while the liquid flows out to the activated sludge process. The digestion period or the ratio of the total tank volume to night soil to treat per day is 20 to 30 days. In the current practice, the digesters are maintained at 35 to 37 C by injecting steam, which is produced in a boiler by using the generated gas as fuel. The overall $BOD_5$ removal by the anaerobic digestion is about 80 %.

Anaerobic digestion has many advantages over aerobic biological processes. It produces little excess sludge, and the sludge is stabilized and sanitary enough to be used as fertilizer. It is a self sustaining process in energy requirements. It requires a long start-up period, but the performance after then is stable without any difficult maintenance works. The sole weak point of anaerobic digestion itself may be that it requires a relatively large initial investment in cold climate regions. The digestion requires heat-insulation structures in such cases.

Night soil treatment plants recently built in Japan rarely adopted the anaerobic digestion / activated sludge system, becuse nitrogen removal in the biological treatment stage is required for efficint used of advanced treatment processes. However, the use of anaerobic digestion in night soil treatment should be worthy to be evaluated in warm climate countries such as Indonesia. In this case, the anaerobic digesters may be constructed with less investment, because they did not require structures of heat insulation. Running of the plant also may be much cheaper, because warming the gas genera

*** Aerobic Digestion / Activated Sludge System ***

Following the anaerobic digestion / activated sludge system, the aerobic digestion / activated sludge system was soon authorized as a standard technology for collective night soil treatment plants. It was extensively used for a while due to the smaller requirements of investment. The extensive use was backed up by improvement of sludge dewatering technology.

This system uses aerobic digestion in stead of anaerobic digestion for the first treatment technology. The aerobic digester is one third of the anaerobic digester in volume, and it does not require structures of heat insulation. It is because a large amount of heat is generated biologically in aerobic treatment of strong wastewater such as night soil.

When compared with the anaerobic digestion, the aerobic digestion consumes more electric power. It produces more excess sludge, and the sludge is unstable, so that the sludge management is more expensive. In usual practice, the sludge is thickened and dewaterd, and then dried and incinerated. Another defect of this system is the unstable performance due to the excessive rise of the reactor temperature, which occasionally exceeds 45 C even in cold climate regions.

Although nitrogen compounds is partially removed in the aerobic digester, the efflent from the system also can not meet the requirement of the advanced treatment processes. The use of the system therefore has diminished.

*** Biological Denitrification System ***

The biological denitrification system uses biochemical reactions of two sorts of bacteria. One is nitrifying bacteria that oxidize ammonia in night soil to nitrites or nitrates under aerobic conditions, the other is denitrifying bacteria that reduce the oxidized nitrogen compounds into nitrogen gas in the course of degradation of carbon compounds in night soil into carbon dioxide under anoxic (oxygen free) conditions.

Various configurations have been developed for the system, but typical one is composed of four tanks in series;

(1) 1st denitrification tank : anoxic
(2) nitrification tank : aerobic
(3) 2nd denitrification tank : anoxic
(4) reaeration tank : aerobic

In the plant of this configuration, raw nigh soil enters the 1st denitrification tank, where nitrites/nitrates containing mixed liquor is recycled from the following nitrification tank. Denitrifying bacteria there decompose BOD substances along with reduction of oxidized nitrogen compounds in the recycled liquor. Ammonia oxidation by nitrifying bacteria takes place in the nitrification tank which is aerated by air bubbling. A large part of the oxidized nitrogen compounds thus produced is car-

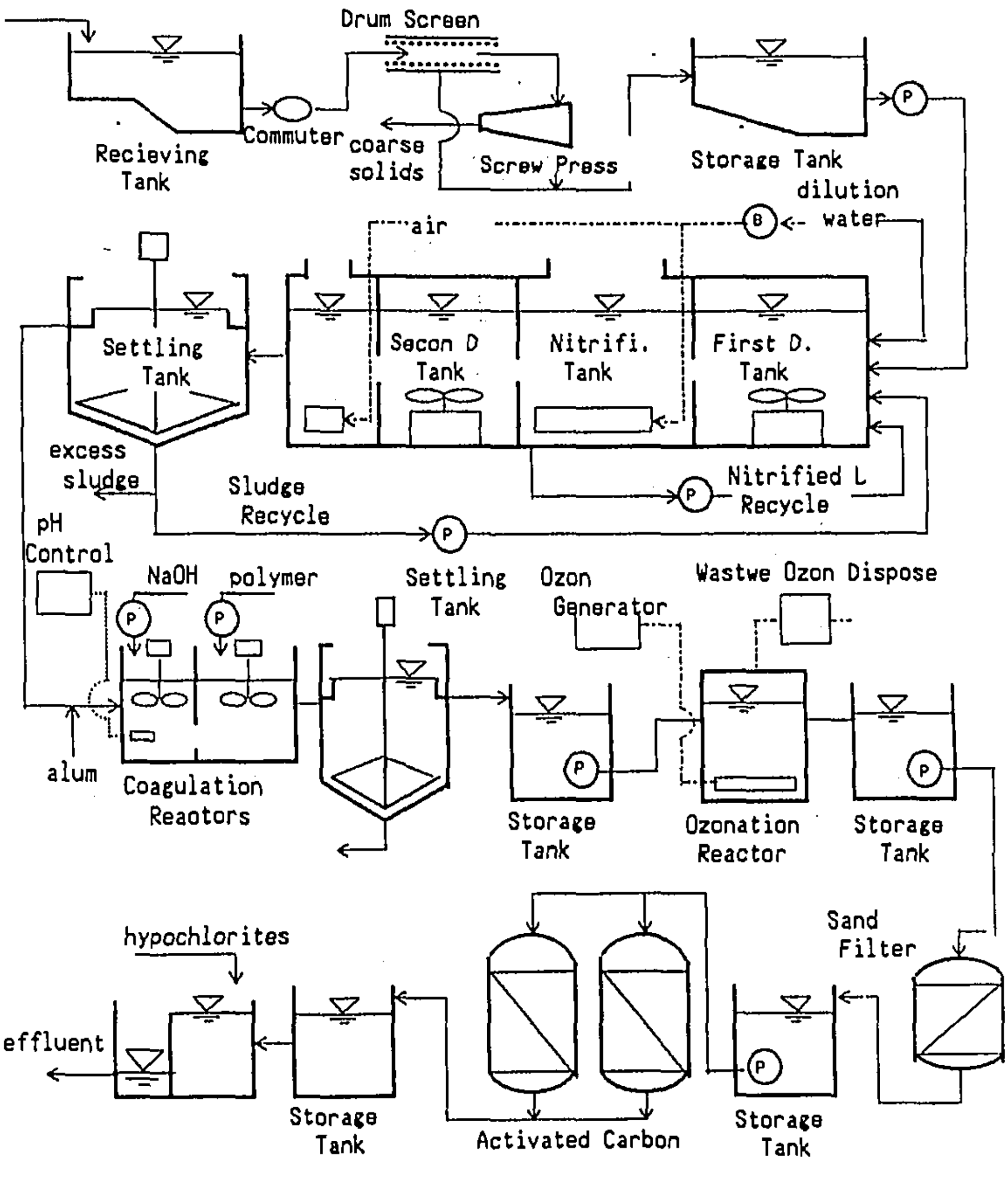



Fig. 14 Flow of Denitrification System plus Advanced Treatment

Table 4 Performance of Denitrification System + Advanced Treatment

Ohtate Wide Area Santation Union's Second Treatment Plant
(Denitrification - Alum Coagulation - Sand Filtration - A.C.Adsorption)
Yearly average in F.Y. 1985 ( 9 measurements per month)

| | Screened Night Soil | Denitrif. Out-put | Coagu. Out-put | Activ.C Out-put | Final Effluent |
|---|---|---|---|---|---|
| Flow (kl/D) | 150 | 585 | 660 | 660 | 800 |
| Temp (C) | ----- | 21.5 | 19.2 | ---- | ---- |
| p H | 8.2 | 6.9 | 6.3 | 6.4 | 6.4 |
| $BOD_5$ (mg/L) | 9670 | 14.4 | 1.7 | 2.0 | < 1 |
| S S (mg/L) | 10540 | 24.4 | 6.2 | 2.2 | 2.5 |
| $COD_{Mn}$ (mg/L) | 4210 | 79.4 | 33.1 | 8.4 | 5.8 |
| $NH_3$-N (mg/L) | 2280 | 1.0 | 1.2 | 1.1 | 1.3 |
| T K-N (mg/L) | 3180 | 11.6 | 6.5 | 4.4 | 3.0 |
| $NO_x$-N (mg/L) | ----- | 2.2 | 1.5 | 1.9 | 1.8 |
| T - N (mg/L) | 3180 | 13.8 | 8.0 | 6.3 | 4.8 |
| T - P (mg/L) | ----- | 22.5 | 0.3 | 0.5 | 0.2 |
| Color (deg ) | ----- | 455 | 160 | 27 | 8 |
| Cl- (mg/L) | 2450 | 630 | 555 | 555 | 460 |
| NCB(cels/mL) | ----- | 620 | 40 | 180 | 0 |

| Treatment Cost ( per kl-Night ) | |
|---|---|
| Electric Power | |
| 61.8 kWH | 1490 yen |
| Fuel | |
| 9.1 L | 615 yen |
| Chemicals | |
| | 1435 yen |
| Total | 3540 yen |

| Chemical Requirement ( per kl-Night ) | | |
|---|---|---|
| NaOH | 5.6 .kg | 176 yen |
| alum | 10.8 kg | 260 yen |
| polymer | 0.01 kg | 10 yen |
| polymer | 1.19 kg | 641 yen |
| metanol | 0 | 0 |
| NaClO | 1.8 kg | 58 yen |
| A. C | 0.6 kg | 290 |

ried to the 1st denitrification by the recycle of the mixed liquor, and the remainder part is introduced to the 2nd denitrification, where the oxidized nitrogen compounds are reduced by denitrifying bacteria. For purpose of speeding up the denitrification, an small amount of methanol is added in usual cases, but it is not an indispensable operation. The reaeration tank is provided for removal of excessively dissolved nitrogen gas to facilitate the solid liquid separation in the settling tank.

The first night soil treatment plant using this system was installed in 1976, and currently most newly constructed plants adopt this system.

## 5. SUMMARY AND CONCLUSION

This paper outlines the history and the current state of night soil treatment in Japan. The context may be summarized as follows;

(1) The collective night soil treatment system has been developed as a means to solve the emergent state of night soil disposal which was caused by the sudden stop of the land application.

(2) The collected night soil treatment has sustained the urban sanitation and the water pollution control with moderate investment, substituting for the modern sewerage system yet to be constructed.

(3) Anaerobic digestion was well suited to the treatment of the collected night soil when the demands on the effluent pollution levels were moderate.

The sanitation system, especially that of houses seem to be a part of national culture. Therefore, a system of night soil disposal best suited to one country is not necessarily appropriate to other countries. To find the system best suited to a country, intensive studies by the sanitary engineers in the country may be required.

# STATE-OF-THE-ART ONSITE DOMESTIC WASTEWATER TREATEMENT FACILITY AND EDUCATION FOR SANITARY ENGINEERS IN JAPAN

Mr. Takao WATANABE

Senior Sanitary Engineer,

Japan Education Centre of Environmental Sanitation

COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR
Jakarta, 27 - 28 February 1989

# State-of-The-Art Onsite Domestic Wastewater Treatement Facility and Education for Sanitary Engineers in Japan

T.WATANABE
JAPAN EDUCATION CENTRE OF ENVIRONMENTAL SANITATION

KEY WORDS

On-site treatment; Population; Small scale facility; Contaminant discharge Hydraulic loading; Anaerobic filter; Contact Aeration; Biochemical oxygen demand (BOD) ; Operation and maintenance (O&M) ; Education and Training

JOHKASOU: Septic tanks, small scale treatment systems for sanitary wastewater owned by residents ranging from household up to 10,000 P.E.

TANDOKU(-JOHKASOU): A type of JOHKASOU which treats only blackish water from flush toilets.

GAPPEI(-JOHKASOU): A type of JOHKASOU which treats combined blackish and gray wastewater; total household liquid waste treatment.

## INTRODUCTION

In Japan, sanitary wastewater is treated not only by large municipal treatment plants but also by smaller scale plants in small community such as towns and treated by villages having less than 30,000 population. Sanitary wastewater is also treated by JOHKASOU. Thus the type of treatment facilities are different in Japan depending on local conditions.

JOHKASOU's are installed and owned by the residents,ranging from household capacity up to about 10,000 P.E., and cover approximately one quarter of the total population of Japan.

Our Centre and the Ministry of Health and Welfare has been devoting much effort since 1978 for the development of different technologies for JOHKASOU's with the capacity of 10 P.E. or less.

Through our R&D activities 5 different types of JOHKASOU's have been successfully developed adopting activated sludge and bio-filter processes. We have also carried out field tests for each of these newly developed JOHKASOU's for approximately 3 years, and the results satisfied all of the following objectives:

(1) Consistently good effluent quality despite large fluctuations of the influent hydraulic and biological loadings as is typical with domestic wastewater discharge. Effluent water quality was consistently 20mg/ℓ or lower on average for $BOD_5$, which was as good as large scale municipal waste water treatment facilities.
(2) Easy maintenance.
(3) Considerable reduction of O&M expense, such as operating power and sludge removal costs.
(4) Reduction of initial cost and installation space.

Our Centre has also trained, under systematic training program, for many sanitary engineers engaging in the installation and maintenance of JOHKASOU's in order to promote the spread of correct information and new technologies.

Due to the success of these developments, JOHKASOU's have proved to be ideal for combined treatment of blackish and gray wastewater from individual homes in areas not being serviced by main sewer systems.

## 1. SITUATION OF SEWER SERVICE AND TREATMENT OF DOMESTIC WASTEWATER IN JAPAN

Total Population 120,000 (Thousands)

- Users of Flush Toilets 70,783
  - Connected to Municipal WWTP 37,701
  - Users of JOHKASOU's 33,083
- Users of Cesspits 51,085

The use of JOHKASOU's is the alternative means to the public sewage works to enable the use of flush toilets.

In early days, JOHKASOU's were regarded as temporary means till public treatment facilities were built. However, because of limited space and housing development situations, building schedule for sewer facilities have been considerably delayed. Due to cost effectiveness and/or unavailability of sewer services at the time of development of towns, JOHKASOU's are widely used.

There are two types of JOHKASOU: the former is called TANDOKU which means "separate" treating only blackish water, while the latter called GAPPEI which means "combined" treating blackish and gray water, i.e. total household liquid waste. The classified total numbers as of March, 1987 are :

| | | |
|---|---|---|
| TANDOKU | 5,717,482 | Units |
| GAPPEI | 84,335 | Units |

The above figures indicate that the numbers of TANDOKU are much larger and consequently gray wastewater (wastewater from kitchins, washing mashines and baths) are being discharged without treatment. The situation of untreated disposal of gray water is the same in areas where residents are using cesspits instead of flush to toilets.

## 2. CONTAMINANTS DISCHARGE TO PUBLIC WATERWAYS

The following are the classified numbers of JOHKASOU as of March 1987 based on the design capacity:

| Capacity | | | | Total Nos. | Classified Nos. | |
|---|---|---|---|---|---|---|
| Up to | | 20 | P.E. | 4,889,429 | TANDOKU: | 5,717,482 |
| 21 | ~ | 100 | 〃 | 757,717 | GAPPEI: | 71,261 |
| 101 | ~ | 500 | 〃 | 141,597 | | |
| 501 | ~ | 1000 | 〃 | 7,600 | | |
| 1001 | ~ | 2000 | 〃 | 3,404 | | |
| 2001 | ~ | 3000 | 〃 | 1,057 | | |
| 3001 | ~ | 4000 | 〃 | 314 | TANDOKU: | ≒ 0 |
| 4001 | ~ | 5000 | 〃 | 161 | | 13,074 |
| 5001 | ~ | 10000 | 〃 | 443 | | |
| 10001 | or over | | 〃 | 95 | | |

Most of JOHKASOU's with the capacity of 500 P.E. or less are TANDOKU type, treating only blackish water. For the capacity of 501 P.E. or larger, GAPPEI type is being used for the design effluent quality of BOD 20 mg/ℓ. The larger the facility capacity, the higher the contaminant loading to public water way becomes. Consequently combined treatment systems (GAPPEI) with cleaner effluent are required.
From the above, it can be seen that the smaller capacity systems have higher contributory factors for water contamination.
The following is a case study of contaminant loading per capita per day to the public waterway when TANDOKU type treatment is adopted;

| | |
|---|---|
| Total BOD discharge: | 40 ~ 52 gBOD/capita/day |
| BOD discharge by night soil + urine: | 13 gBOD/capita/day |

Then,

| | | |
|---|---|---|
| Total BOD discharge | 40 ~ 52 gBOD/capita/day | 100% |
| Night soil + urine: | 13 gBOD/ 〃 | 25 ~ 33% |
| Gray water | 27 ~ 39 gBOD/ 〃 | 68 ~ 75% |

Hence, by assuming BOD removal rate as 65% and effluent quality as 90mg/ℓ BOD for TANDOKU type JOHKASOU's, BOD discharge rates are:

| | |
|---|---|
| Effluent BOD from JOHKASOU's | 4.55 gBOD/capita/day |
| Untreated gray water | 27 ~ 39 gBOD/ 〃 |
| Total BOD discharge | 31.55 ~ 43.55 gBOD/capita/day |

This amount is equivalent to about 78.9 ~ 83.8% of the total BOD discharge. Thus, TANDOKU type JOHKASOU do not contribute to the reduction of contaminants load to the public water ways as expected. In other words, the water contamination in the public waterways of Japan today can be attributed mainly to the discharge of untreated household gray water.

Therefore it is important to treat blackish water combined with gray water by JOHKASOU's, even though the treatment capacity is small, and this is one of the most important themes in Japan for the protection of the environment.

## 3. APPRAISAL OF ADVANCED TECHNOLOGIES AND OPTIMUM TREATMENT METHODS

When the conventional activated sludge process, which is commonly applied to the municipal wastewater treatment systems, is adopted to small package systems of 20 P.E. or less capacity, sludge carry-over problems are encountered resulting with difficulty in maintaining treatment efficiency owing to the abrupt fluctuations of hydraulic loading ---- for instance, gray water discharge rates from bath or washing machines are often recorded at 30 ~ 50% of total daily hydraulic loading within an hour ---.

Fig.1 shows an example of flow pattern discharged from private houses.

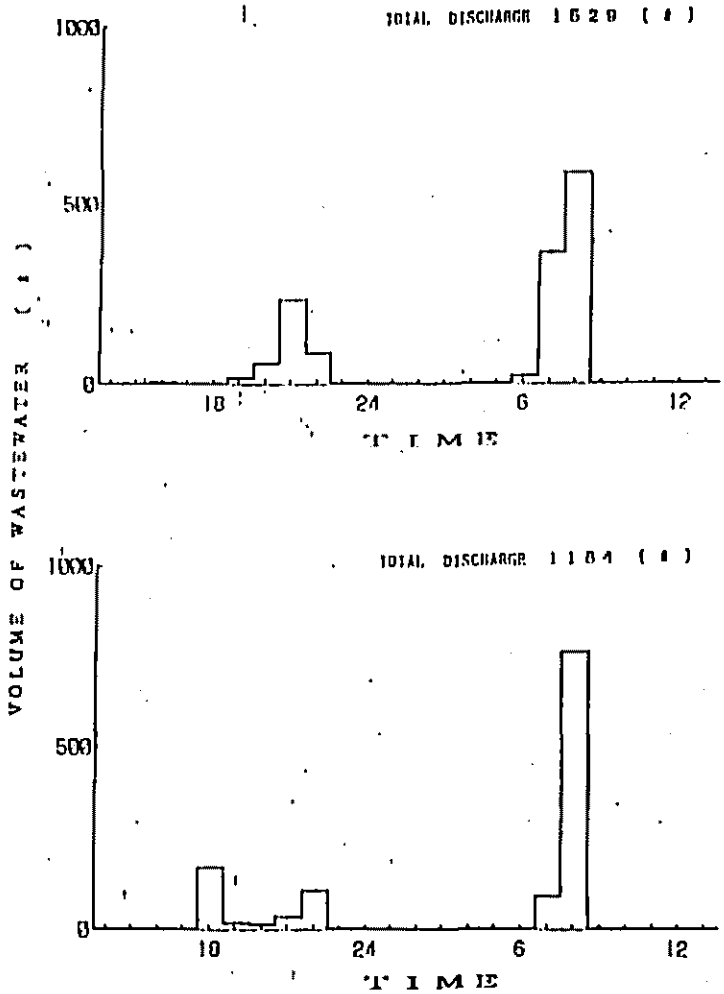



FIG.1 CHARACTERISTICS OF HOUSE-HOLD WASTEWATER DISCHARGE

Table 1 shows average, minimum and maximum hourly discharge of different family sizes.

Table 1 Average, minimum and maximum hourly discharge

| Persons | Sample Numbers | Average [ℓ/hr] | Minimum [ℓ/hr] | Maximum [ℓ/hr] |
|---|---|---|---|---|
| 3 | 16 | 278 | 123 | 946 |
| 4 | 31 | 308 | 81 | 1091 |
| 5 | 32 | 301 | 117 | 767 |
| 6 | 15 | 354 | 179 | 660 |

Fig.2 is the hystogram of hourly discharge flows of the samples.

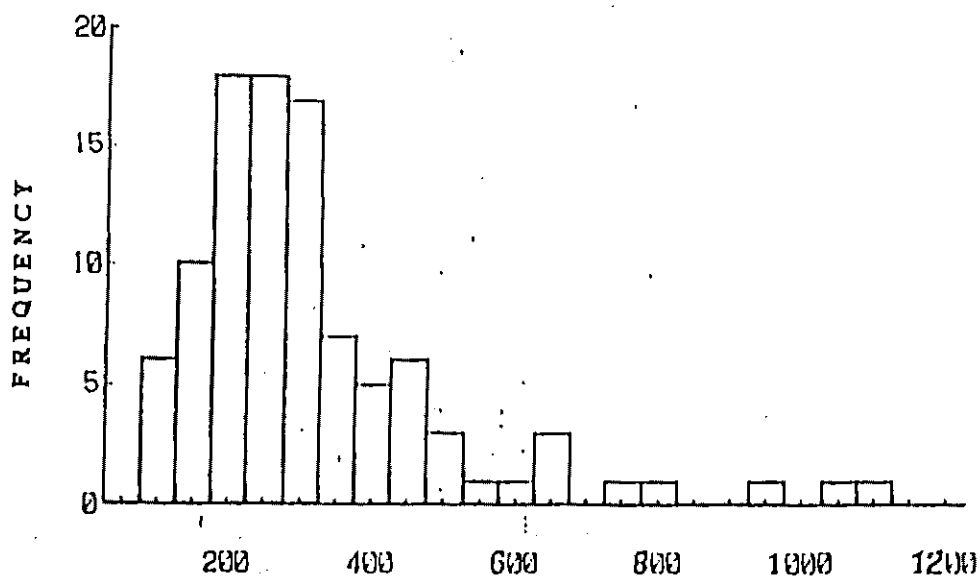
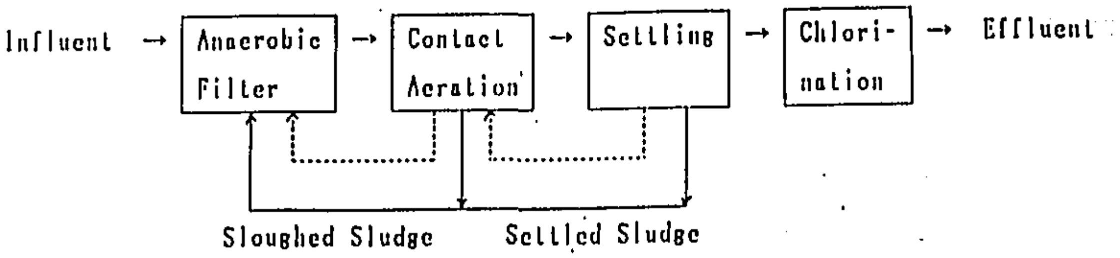



Fig.2 Hystogram of hourly discharge [ ℓ/hr. ]

Because wastewater disposals from washing machine, bath and kitchen of each house are respectively concentrated to the typical hours of a day, on-site treatment facilities receive very high hourly hydraulic loadings.

Consequently, small capacity systems must eliminate sludge carry-over and be operated satisfactorily with much easier operation and maintenance.

For the above purposes, the contact aeration process was introduced for the secondary treatment to hold enough biomass and to treat sewage with least possible MLSS concentration, and also anaerobic media was incorporated for the anaerobic primary treatment in order to minimize waste sludge production at the secondary aerobic process.
The following is the block diagram of the system:




The structure of the JOHKASOU is shown in Fig. 3

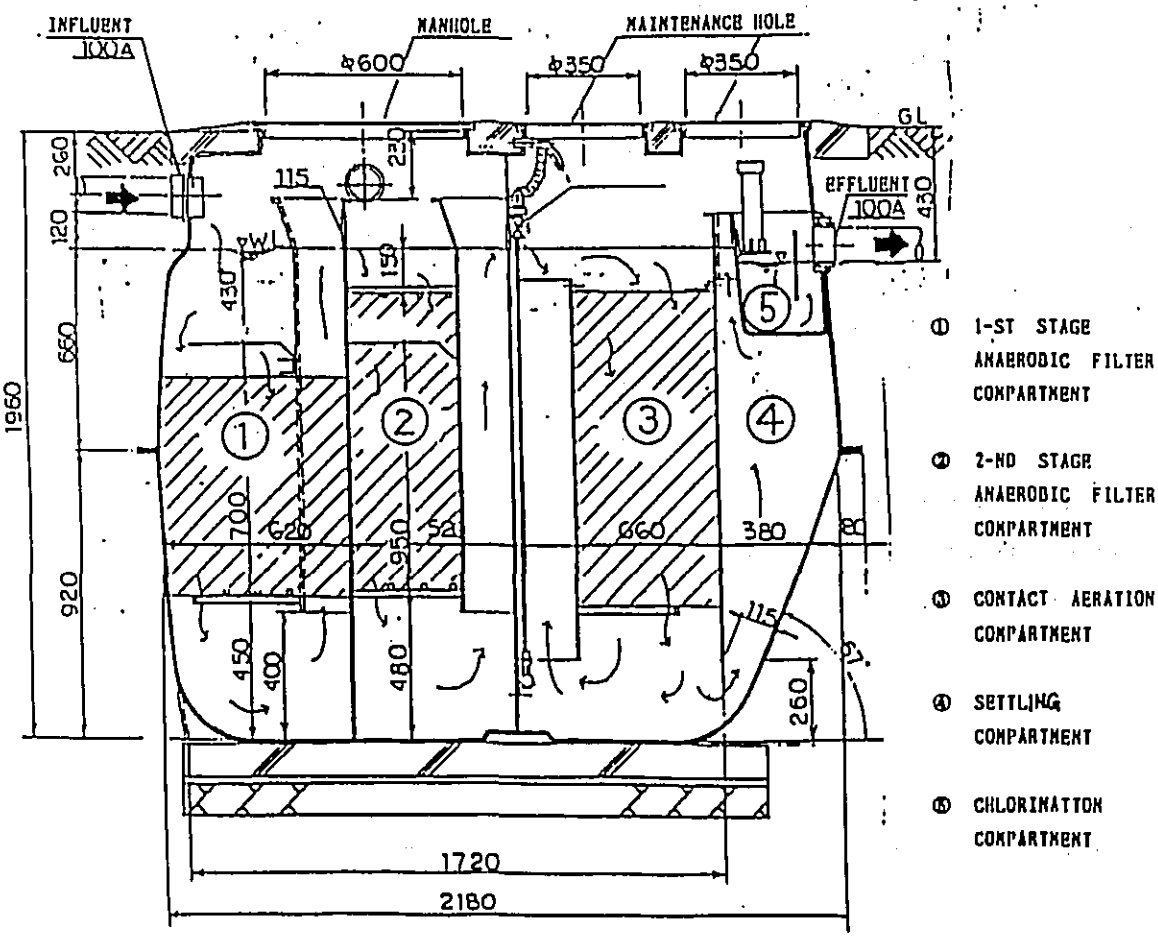



Fig.3 Structure of the JOHKASOU ( anaerobic filter process )

The volume of each compartments ( in $m^3$ ) is determined from the family size ( n ) as follows:

| | | | |
|---|---|---|---|
| Anaerobic Filter Tank : | $n \leqq 5$ | $V = 1.5$ | $m^3$ |
| | $6 \leqq n \leqq 10$ | $V = 1.5 + 0.4 (n - 5)$ | |
| | $11 \leqq n \leqq 50$ | $V = 3.5 + 0.2 (n - 10)$ | |
| Contact Aeration Tank : | $n \leqq 5$ | $V = 1$ | |
| | $6 \leqq n \leqq 10$ | $V = 1 + 0.2 (n - 5)$ | |
| | $11 \leqq n \leqq 50$ | $V = 2 + 0.16 (n - 10)$ | |
| Settling Tank : | $n \leqq 5$ | $V = 0.3$ | |
| | $6 \leqq n \leqq 10$ | $V = 0.3 + 0.08 (n - 5)$ | |
| | $11 \leqq n \leqq 50$ | $V = 0.7 + 0.04 (n - 10)$ | |
| Chlorination Tank : | Min. 15mins of chlorine contact | | |
| n : | Design capacity (P.E.) | | |

The actual on-site performance data are shown in Fig.4

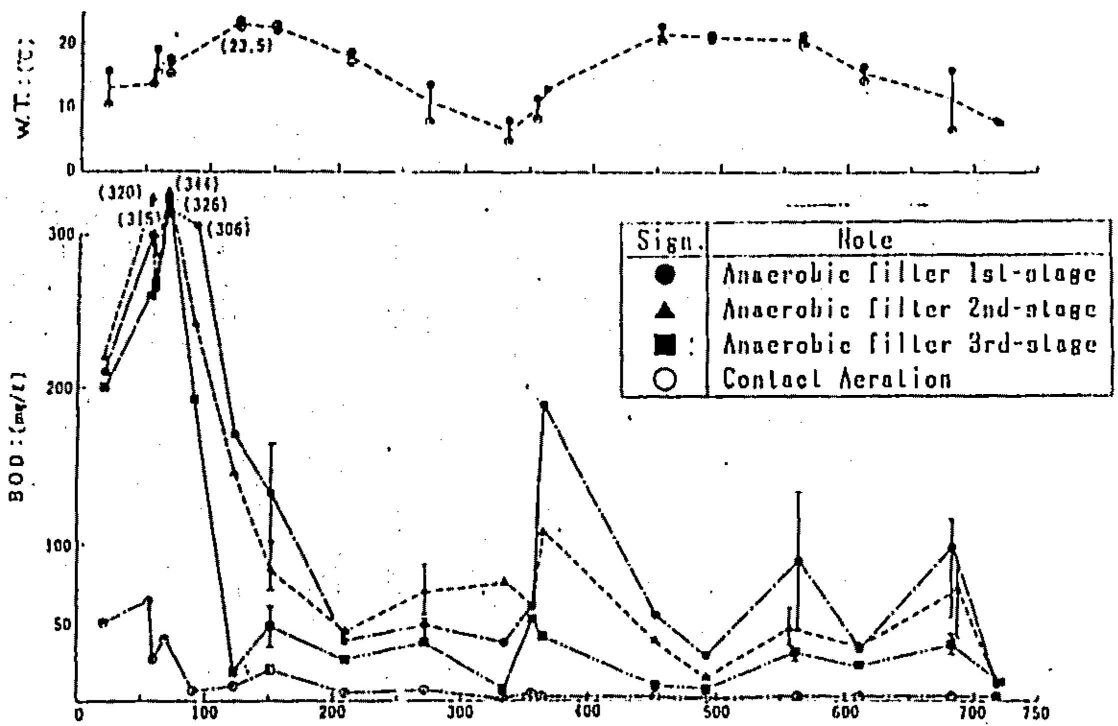
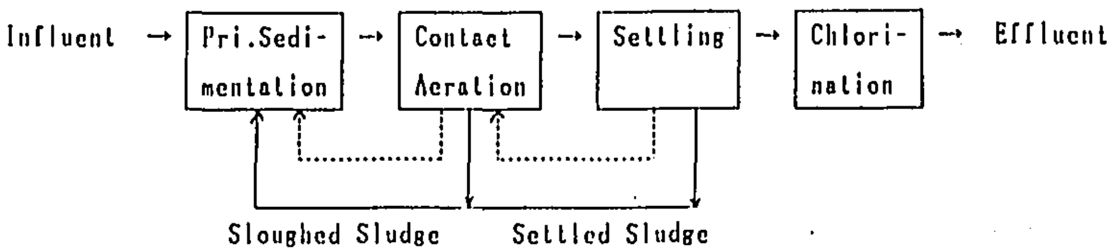



Fig.4 Performance data of the actual on-site anaerobic filter process

It took about 100 days to stabilise anaerobic filter functions, and thereafter the effluent quality of the anaerobic process was consistently about 50mg/ℓ BOD. Consequently, the biological loading of the following aerobic treatment (contact aeration) process was considerably lowered and the final effluent quality of lower than 20mg/ℓ BOD was secured without difficulty.

There are alternative methods to use primary sedimentation compartment in lieu of anaerobic filter, of which the flow sheet is shown in Fig.




The section of this type of JOHKASOU is shown in Fig.5

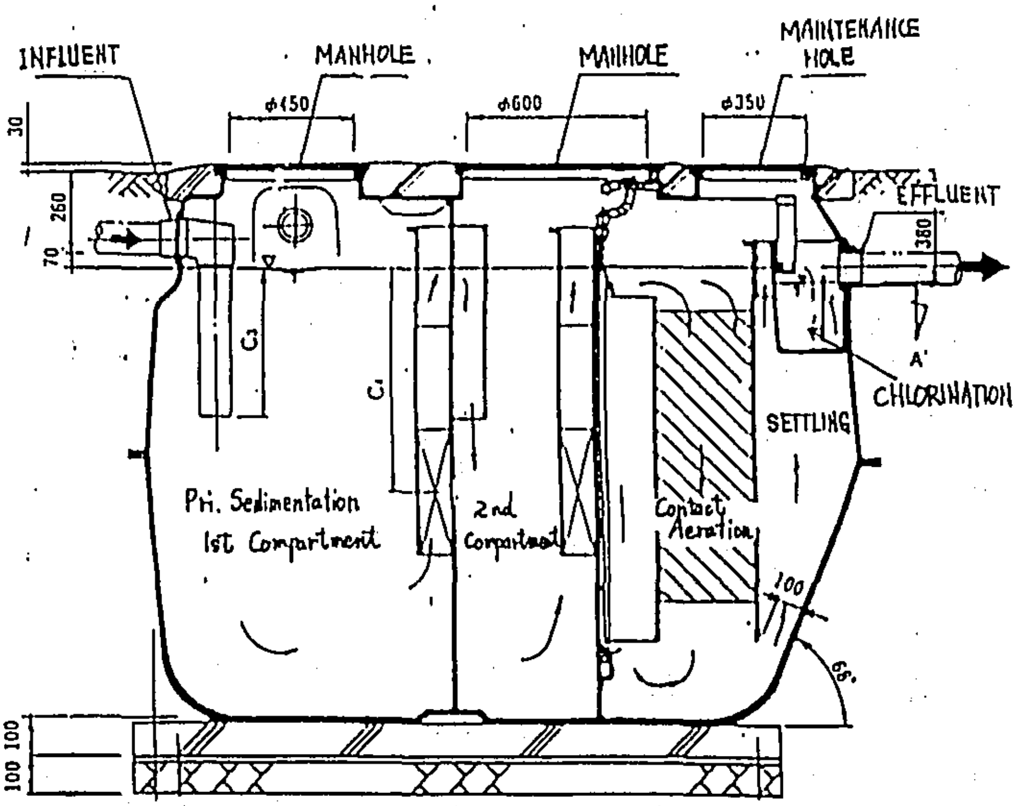



Fig.5 Structure of the JOHKASOU ( pri. sedimentation process )

The volume of the Primary Sedimentation Compartment (in $m^3$) is determined from the family size ($n$) as follows:

| | | |
|---|---|---|
| Pri.Sedimentation Tank : | $n \leqq 5$ | $V = 2.5$ $m^3$ |
| | $0 \leqq n \leqq 10$ | $V = 2.5 + 0.5 \ (n - 5)$ |
| | $11 \leqq n \leqq 50$ | $V = 5.0 + 0.25 \ (n - 10)$ |

The designs of the Contact Aeration Compartment and thereafter are remained unchanged.

This treatment process assures effluent quality of 20 mg/ℓ BOD or lower, which is as good as that of municipal wastewater treatment plants.
The following table shows actual performance:-

| | Facility A | Facility B | Facility C |
|---|---|---|---|
| SS (mg/ℓ) | 4.2 | 9.1 | 6.5 |
| COD (mg/ℓ) | 18.0 | 25.5 | 21.5 |
| BOD (mg/ℓ) | 4.0 | 10.0 | 13.0 |

General specifications and the flow sheet of other GAPPEI type JOHKASOU's are shown in the following Table 2 , 3 .

Table 2 Basic flow sheet of single type treatment disposal tank

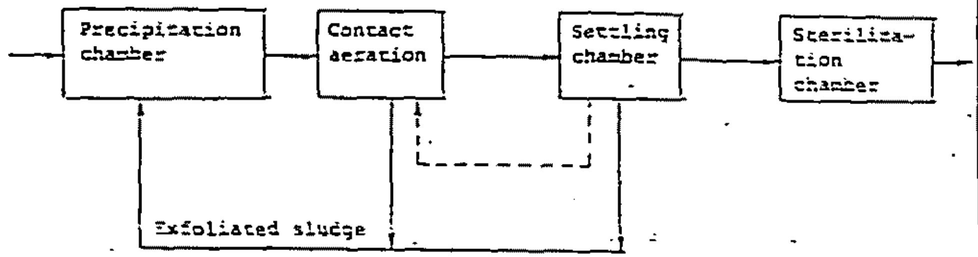
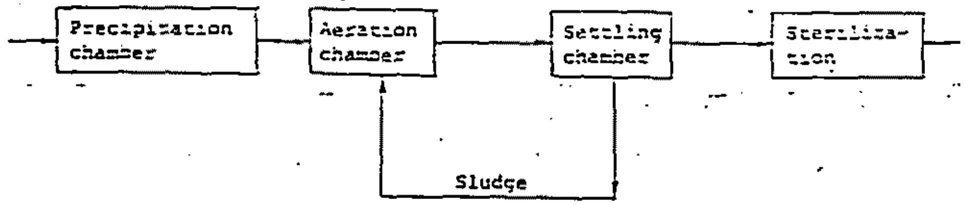
| Treatment process | Number of persons waste to be treated (persons) | Flow sheet | Remarks |
|---|---|---|---|
| Separation contact aeration | Less than 500 |  | Notification No. 1 |
| Separation aeration | Less than 500 |  | Notification No. 1 |
| Trickling filter | Less than 500 |  | Notification No. 1 |

Table 3 Basic flow sheet of combination type treatment disposal tank

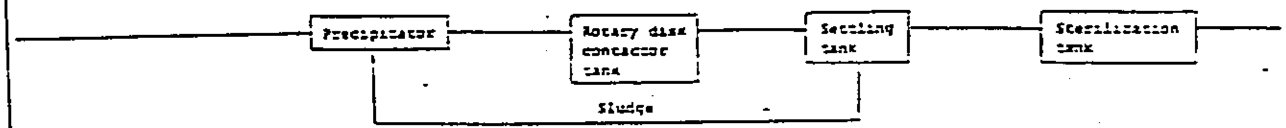
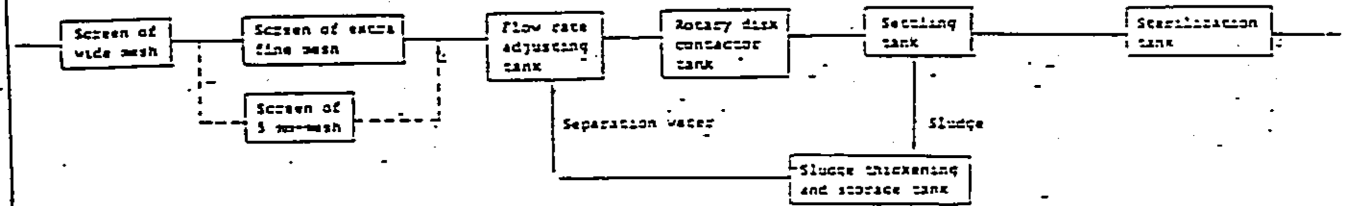
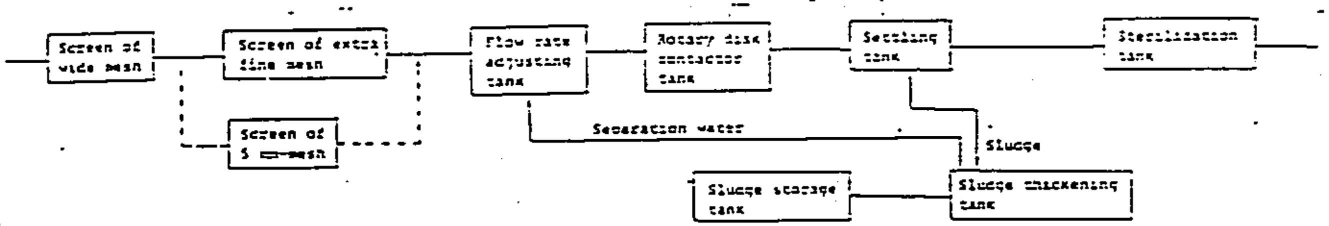
| Treating process | Number of persons waste to be treated (persons) | Flow sheet | Remarks Note |
|---|---|---|---|
| Rotary disk | 51 - 500 |  | Applicable to Notification No. 2 and 3. |
| | 201 - 500 |  | |
| | More than 501 |  | Applicable to Notification No. 2, 3 and 6. The upper limit of No.2:2000 persons |

Table 3 (Continue)

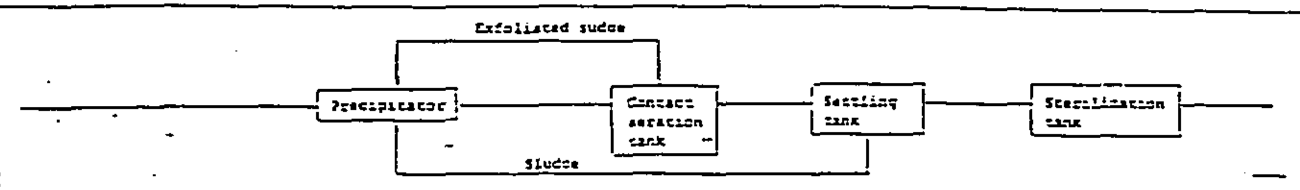
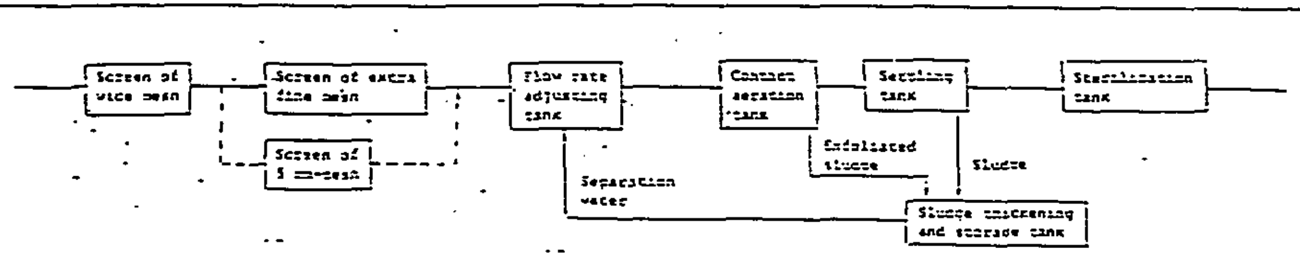
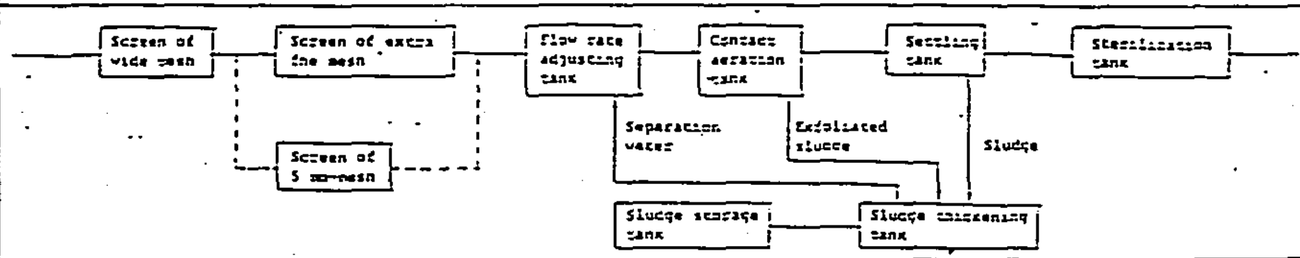
| Treating process | Number of persons waste to be treated (persons) | Flow sheet | Remarks Note |
|---|---|---|---|
| Contact aeration | 51 - 500 |  | Applicable to Notification No. 2 and 3. |
| | 201 - 500 |  | |
| | More than 501 |  | Applicable to Notification No. 2, 3 and 6. The upper limit of No.2:2000 persons |

Table 3 (Continue)

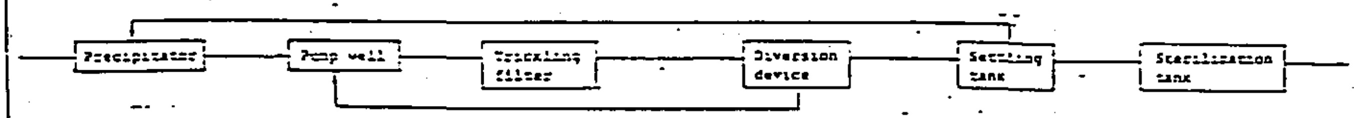
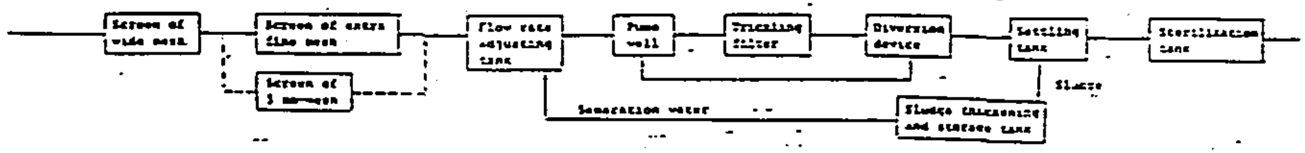
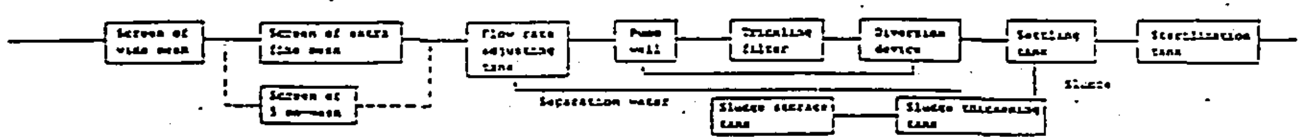
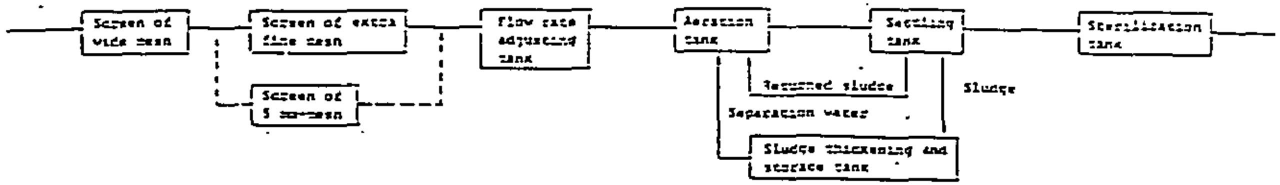
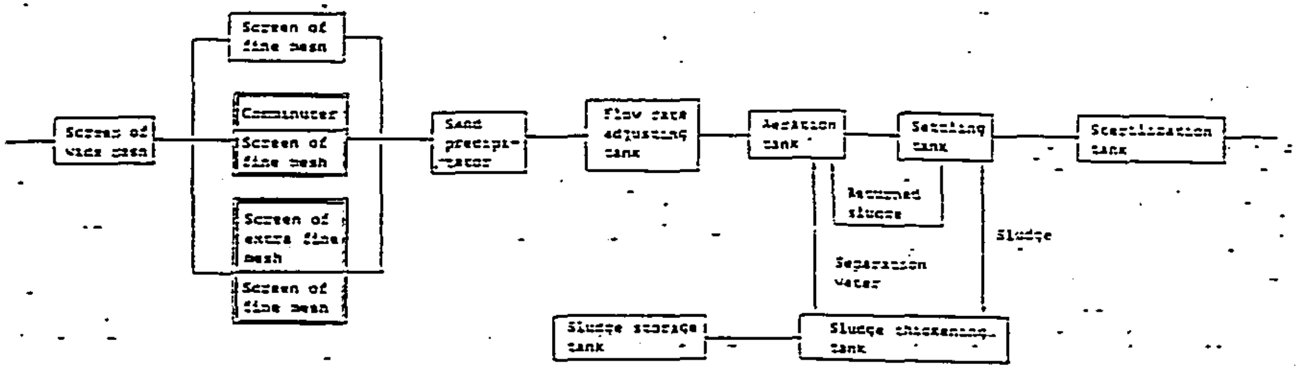
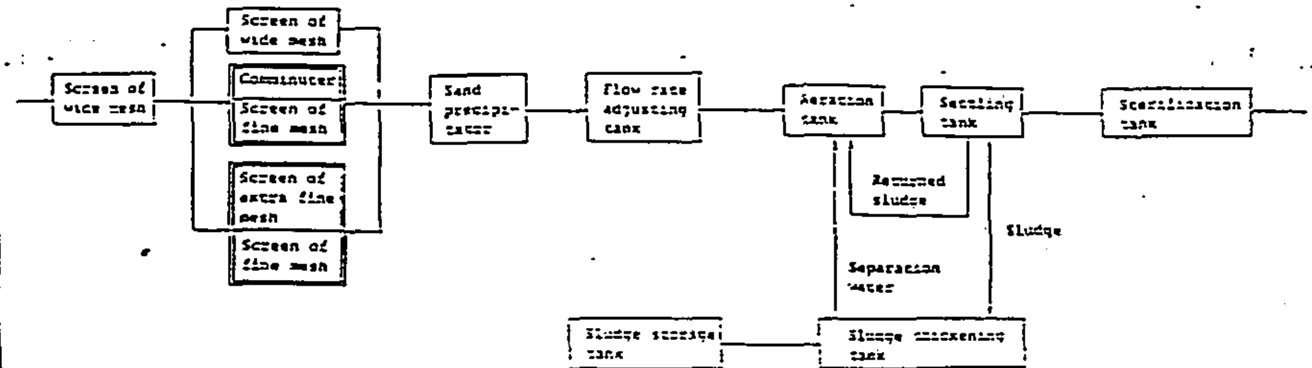
<table>
<tr><th>Treating process</th><th>Number of persons waste to be treated (persons)</th><th>Flow sheet</th><th>Remarks Note</th></tr>
<tr><td rowspan="3">Trickling filter</td><td>51 - 500</td><td>
</td><td rowspan="2">Applicable to Notification No. 2 and 3.</td></tr>
<tr><td>201 - 500</td><td>
</td></tr>
<tr><td>More than 501</td><td>
</td><td>Applicable to Notification No. 2, 3 and 6. The upper limit of No.2:2000 persons</td></tr>
</table>

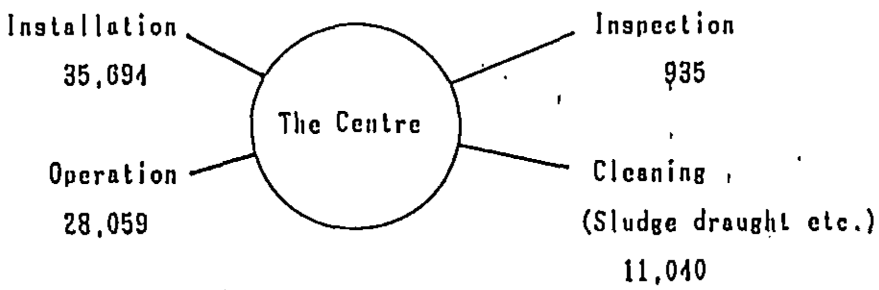
Table 3 (Continue)

<table>
<tr><th>Treating process</th><th>Number of persons waste to be treated (persons)</th><th>Flow sheet</th><th>Remarks Note</th></tr>
<tr><td rowspan="2">Extended aeration</td><td>201 - 500</td><td>
</td><td>Applicable to Notification No. 2 and 3.</td></tr>
<tr><td>201 - 5,000</td><td>
</td><td>Applicable to Notification No. 2, 3 and 6. The upper-limit of No.2:2000 persons</td></tr>
<tr><td>Standard activated sludge</td><td>more than 5,001</td><td>
</td><td>Applicable to Notification No. 3 and 6.</td></tr>
</table>

Note: Screen of extra fine mesh can be installed next to flow rate adjusting tank.

4. EDUCATION AND TRAINING FOR SANITARY ENGINEERS

Training Programs of Sanitary Engineers for JOHKASOU's. In 1960's, when demands for flush toilets were rapidly increasing in Japan, JOHKASOU's began to be widely installed. Then proper operation and maintenance of those JOHKASOU's became necessary.
Thus, seminar authorised by the Ministry of Public Health and Welfare started in 1965.
Because of the importance of planning/design/installation, the new regulations were set force in 1971 in order to qualify sanitary engineers for JOHKASOU's.
In 1980 the rules for inspection were introduced to check whether installations and maintenance are being made correctly or not.
Being as the official organization established to train sanitary engineers for the above purposes, the Japan Education Centre of Environmental Sanitation, Foundation, has sent so far the following numbers of qualified engineers to the field:




To acquire the qualifications, there are two ways;
1.To finish the course of relevant seminars.
2.To pass the relevant state-examinations.

These sanitary engineers are registered and requested to receive schoolity when the relevant laws or regulations are altered or newly set force.
Now our Centre holds supplementary seminar from time to time for engineers to improve and/or up-date the technologies using various field data obtained by own Centre.

# SUPPLEMENTAL MATERIAL

# WATERWORKS IN JAPAN (1988)

WATER SUPPLY AND ENVIRONMENTAL SANITATION DEPARTMENT,
MINISTRY OF HEALTH AND WELFARE

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN WATER WORKS ASSOCIATION

# 1. Waterworks Administration of Japan

In Japan, we have five kinds of waterworks according to Waterworks Law.

① Large Scale Public Water Supply (Jo' Suido'): with more than 5,000 of populations to be served (LSPWS)

② Small Scale Public Water Supply (Kan'i Suido'): with 101 to 5,000 of populations to be served (SSPWS)

③ Bulk Water Supply (Yo'sui Kyokyu'): to supply purified water to large and small scale water supply bodies (BWS)

④ Private Water Supply (Sen'yo' Suido'): for private use for dormitory, company's house, sanatorium, etc. and with more than 100 of populations served (PWS)

⑤ Small Scale Private Water Supply: to supply water by receiving tank with more than 10 $m^3$ capacity, (i.e. large size apartment house etc.) (SSP)

Organization of Central Government Concerning Water Supply

| Agency or Ministry | Bureau | Administration |
|---|---|---|
| Environment Agency | Water Quality | Planning of water quality management in the area for public use |
| National Land Agency | Water Resources | Fundamental palanning of water resources development of 5 biggest river basins |
| Ministry of Health and Welfare | Enviromental Health | Authorization, supervision and subsidization of all water supply systems for portable use |
| Ministry of Agriculture, Forestry and Fishery | Agricultural Structure Improvement | Supervision and others of irrigation |
| Ministry of International Trade and Industry | Industrial Location and Environment Protection | Supervision and others of industrial water supply |
| Ministry of Construction | City | Supervision and others of sewage systems |
| | River | Water resources development, flood control and permission of river water use |
| Ministry of Home Affairs | Local Finance | Loan financing arrangement |

Systems of Authorization and Supervision of Waterworks Bodies

- Ministry of Health and Welfare
  - Governor of a Prefecture
    - Large scale public water supply (with 50,000 or — less persons supplied water)
    - Bulk water supply (with 25,000 $m^3$/day or less water supplying ability)
    - Small scale public water supply
    - Private water supply
    - Small scale private water supply
  - Large scale public water supply (with more than 50,000 persons supplied water)
  - Bulk water supply (with more than 25,000 $m^3$/day water supplying ability)

Comments

Ministry of Health and Welfare: Ministry of Health and Welfare is the central administrative organization for waterworks. It does not manage waterworks directly, but guides and regulates waterworks in technique and management on basis of "Waterworks Law".

Prefectural Governor: Public Health Divisions in prefectural governments have supervisory roles for waterworks. They make more practical guidance and regulations for waterworks than the Ministry on Waterworks Law on instruction of the Ministry.

Bulk Water Supply Enterprises: Bulk water supply enterprises supply purified water not for inhabitants directly, but for waterworks with charge. They are conducted by prefectural governments or cooperative associations of municipalities.

## 2. Waterworks and Population Served

In Japan,especially in these two decades, water supply facilities have been constructed very rapidly and the population served by modern water supply systems has also been increasing very much.

However, there are about 7.8 million people still remained unsupplied by the modern water supply systems. Much efforts are required to supply water to these people.

Fig. 1. Population Served in 1986

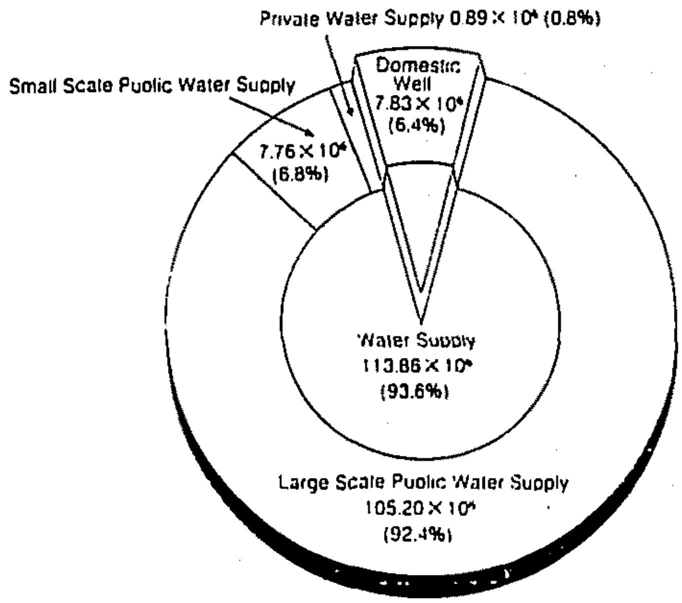



Table-1 Increse of Population Served (unit: × 10³ population)

| Items \ Fiscal Year | 1965 | 1970 | 1975 | 1980 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|
| Total Population (A) | 98,275 | 103,720 | 112,279 | 116,680 | 119,320 | 120,170 | 121,010 | 121,690 |
| Population Served (B) | 68,244 | 83,754 | 98,397 | 106,910 | 110,520 | 111,830 | 112,870 | 113,860 |
| Percentage of Population Served (B/A) | 69.4% | 80.8% | 87.6% | 91.5% | 92.6% | 93.1% | 93.3% | 93.6% |

Table-2. Number of Waterworks in 1986

| | Bulk Water Supply | Large Scale Public Water Supply | Small Scale Public Water Supply | Private Water Supply | Total |
|---|---|---|---|---|---|
| Number of Water Supply Systems | 98<br>(98) | 1,931<br>(1,934) | 11,213<br>(11,303) | 4,172<br>(4,177) | 17,414<br>(17,512) |

( ): 1985

## 3. Population Served in Regions

The percentage of population served in rural areas (towns and villages) is lower than that in urban areas (cities). And there are large differences between the services. In large cities, most people can enjoy drinking water from the water supply systems.

Fig. 2. Population Served in Cities, Towns, and Villages

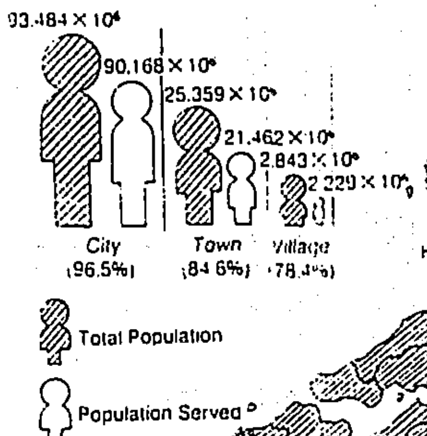



Fig. 3. Percentage of Population Served in 1986

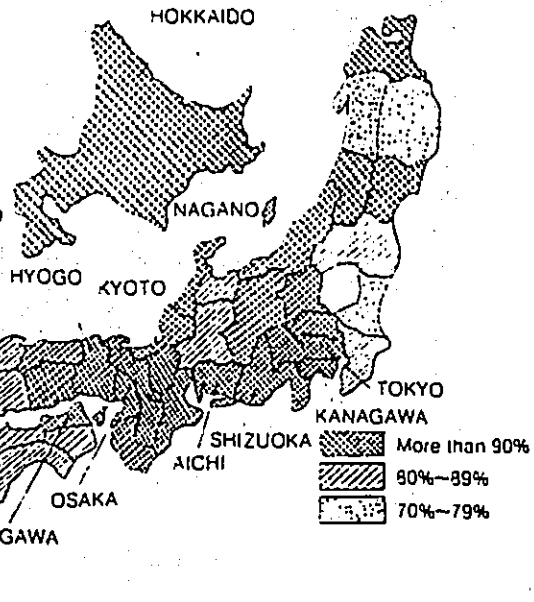



Table-3. Percentage of Population Served in 47 Prefectures in 1985

| Name of Prefecture | Per cent (%) | Name of Prefecture | Per cent (%) | Name of Prefecture | Per cent (%) | Name of Prefecture | Per cent (%) |
|---|---|---|---|---|---|---|---|
| Hokkaido | 92.2 | Tokyo | 99.9 | Shiga | 97.5 | Kagawa | 95.2 |
| Aomori | 92.7 | Kanagawa | 99.6 | Kyoto | 98.5 | Ehime | 88.5 |
| Iwate | 79.1 | Niigata | 95.8 | Osaka | 99.8 | Kochi | 84.7 |
| Miyagi | 94.6 | Toyama | 89.2 | Hyogo | 98.8 | Fukuoka | 87.0 |
| Akita | 80.3 | Ishikawa | 93.8 | Nara | 94.8 | Saga | 86.3 |
| Yamagata | 92.4 | Fukui | 91.0 | Wakayama | 92.7 | Nagasaki | 94.9 |
| Fukushima | 83.1 | Yamanashi | 94.6 | Tottori | 92.2 | Kumamoto | 76.1 |
| Ibaragi | 75.0 | Nagano | 95.7 | Shimane | 88.8 | Oita | 81.9 |
| Tochigi | 81.9 | Gifu | 88.7 | Okayama | 92.8 | Miyazaki | 89.9 |
| Gunma | 97.8 | Shizuoka | 97.4 | Hiroshima | 86.0 | Kagoshima | 90.7 |
| Saitama | 97.7 | Aichi | 98.9 | Yamaguchi | 85.8 | Okinawa | 98.9 |
| Chiba | 89.5 | Mie | 96.4 | Tokushima | 89.8 | Average | 93.6 |

## 4. Service Condition

There exist 17,414 water supply bodies in Japan, and most of them are small-scale.
To secure safe and rational water supply, reorganization of waterworks should be carried out.

Fig. 4 Number of Water Supply Bodies and Annual Consumption in Different Scales

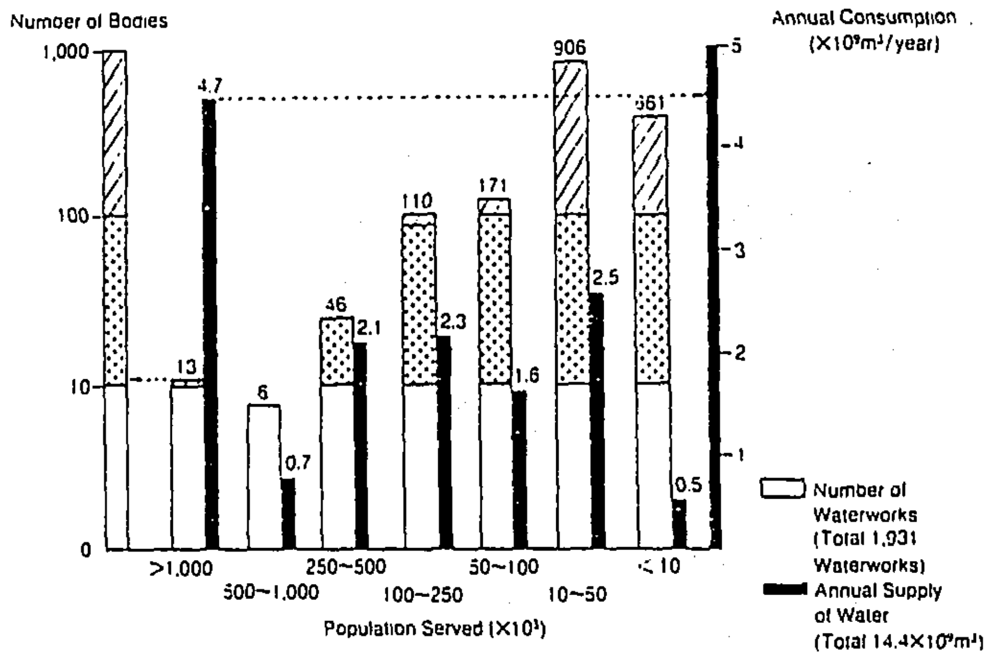



Table-4 Water Demand and Population Served in Different Scales (1986. 4~1987. 4)

| Population Served (X10³) | | Number of Waterworks | Population Served (X10³) | Water Supplied (X10⁹m³/year) | Supplied Water per capita per day (ℓ) | |
|---|---|---|---|---|---|---|
| | | | | | Maximum | Average |
| Large Scale Public Water Supply | More than 1,000 | 13 | 32,046 | 4.7 | 504 | 406 |
| | 500~1,000 | 7 | 4,408 | 0.6 | 475 | 387 |
| | 250~500 | 46 | 15,666 | 2.1 | 458 | 371 |
| | 100~250 | 110 | 17,101 | 2.3 | 455 | 365 |
| | 50~100 | 171 | 11,992 | 1.6 | 462 | 363 |
| | 10~50 | 906 | 19,645 | 2.5 | 457 | 342 |
| | 5~10 | 661 | 4,343 | 0.5 | 509 | 355 |
| | Under Construction | 17 | — | — | — | — |
| | Sub Total | 1,931 | 105,201 | 14.4 | — | — |
| Small Scale Public Water Supply | | 11,213 | 7,764 | 0.8 | 388 | 282 |
| Privat Water Supply | | 4,172 | 893 | 0.06 | — | — |
| | | 17,414 | 113,858 | 15.2 | — | — |

1 liter=0.264 gallon

## 5. Water Consumption and Construction Cost

Annual Consumption is about 15.2 billion cubic meters, or 4.0 trillion gallon in 1986 and it increases year by year.

National subsidy and loan to water supply facilities will be about 716 billions yen (about 5.5 billion dollar) in 1988.

Unit construction cost of water facilities (per m³ per day) has increased gradually in these 10 year (especially dam construction cost). (1 US$ ≒ ¥130)

Table-5. Subsidy and Loan for Construction

(unit: 10⁹ yen)

| | Fiscal Year | 1965 | 1970 | 1975 | 1980 | 1984 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|---|---|---|
| Large Scale Public Water Supply | National Subsidy | — | 4 | 45 | 101 | 106 | 104 | 129 | 124 |
| | Loan | 115 | 165 | 536 | 602 | 530 | 525 | 523 | 525 |
| Small Scale Public Water Supply | National Subsidy | 2 | 4 | 15 | 27 | 24 | 23 | 27 | 23 |
| | Loan | 4 | 7 | 27 | 41 | 34 | 35 | 43 | 44 |

Fig. 5. Subsidy and Loan (per year)

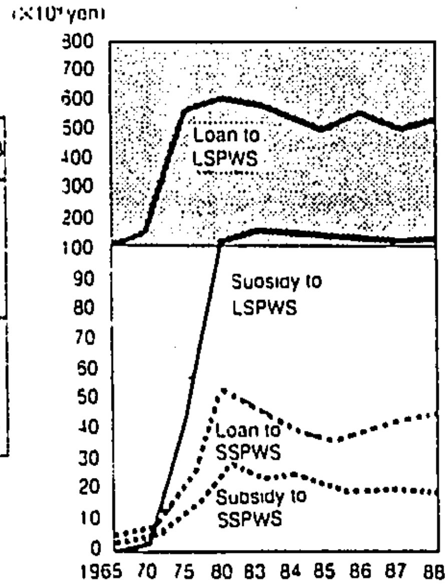



Table-6. Construction Cost(unit: Yen/m³/day)

| Fiscal Year | Large Scale Public Water Supplies | Bulk Water Supplies | Small Scale Public Water Supplies | |
|---|---|---|---|---|
| | | | Yen/capita | Yen/m³/day |
| 1970 | 60,000 | 43,000 | 21,417 | 142,777 |
| 1975 | 156,000 | 212,000 | 84,835 | 565,567 |
| 1980 | 335,000 | 231,000 | 179,765 | 1,198,000 |
| 1986 | 673,000 | 551,000 | 212,769 | 1,418,460 |

Small Scale Public Water Supplies: Maximum water supplied/capita/day=150 ℓ

## 6. Water Resources

69 per cent of water are taken from rivers and storage dams.
Recently storage dams are becoming more and more important as water sources.

Fig. 6. Water Resources of Large Scale Public Water Supplies (unit: $\times 10^9 m^3$) (1986)

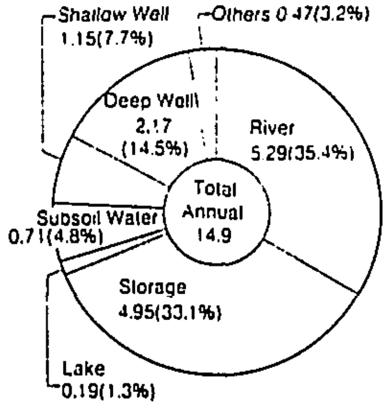



Fig. 7. Constitution of Water Sources in Large Scale Public Water Supplies (1986)

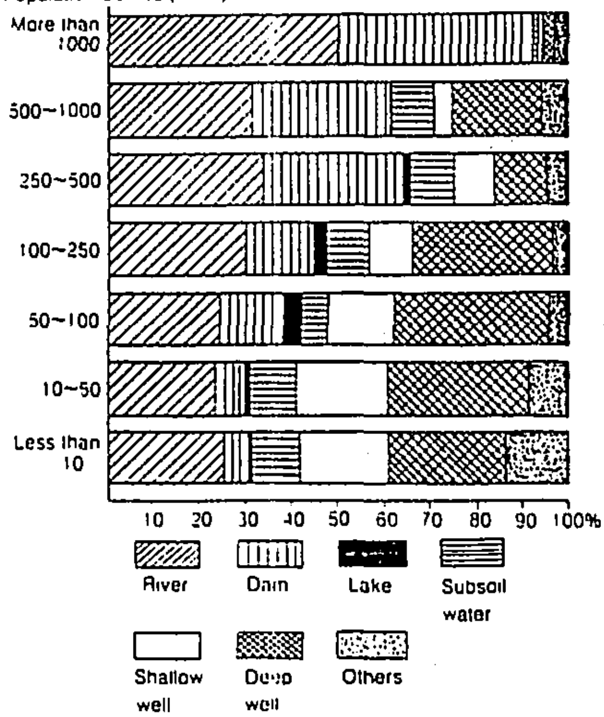



Table-7 Intake Amount (Unit: $\times 10^9 m^3$/year) (including Bulk Water Supply)

| Fiscal yeas | Surface Water (River) | | | Lake | Subsoil Water | Shallow Well | Deep Well | Others | Total |
|---|---|---|---|---|---|---|---|---|---|
| | River | Dam (Direct) | Dam (Flow) | | | | | | |
| 1978 | 5.81 | 1.06 | 2.12 | 0.15 | 1.00 | 0.85 | 2.07 | 0.48 | 13.54 |
| 1979 | 5.83 | 1.06 | 2.22 | 0.17 | 0.96 | 0.91 | 2.02 | 0.49 | 13.66 |
| 1980 | 5.40 | 1.08 | 2.57 | 0.18 | 0.95 | 0.89 | 1.96 | 0.47 | 13.50 |
| 1981 | 5.37 | 1.14 | 2.85 | 0.19 | 0.87 | 0.97 | 2.03 | 0.48 | 13.90 |
| 1982 | 5.42 | 1.22 | 2.84 | 0.20 | 0.86 | 0.98 | 2.04 | 0.50 | 14.06 |
| 1983 | 4.83 | 1.24 | 3.81 | 0.20 | 0.83 | 0.72 | 2.12 | 0.52 | 14.60 |
| 1984 | 5.30 | 1.13 | 3.60 | 0.21 | 0.80 | 1.05 | 2.19 | 0.49 | 14.77 |
| 1985 | 4.87 | 1.21 | 4.07 | 0.19 | 0.74 | 1.13 | 2.18 | 0.49 | 14.88 |
| 1986 | 5.29 | 1.22 | 3.72 | 0.19 | 0.71 | 1.15 | 2.17 | 0.47 | 14.93 |

## 7. Cost of Water

Cost of water supplied per cubic meter is about 146 yen (about US $ 1.0).

Fig. 8 Cost of Water

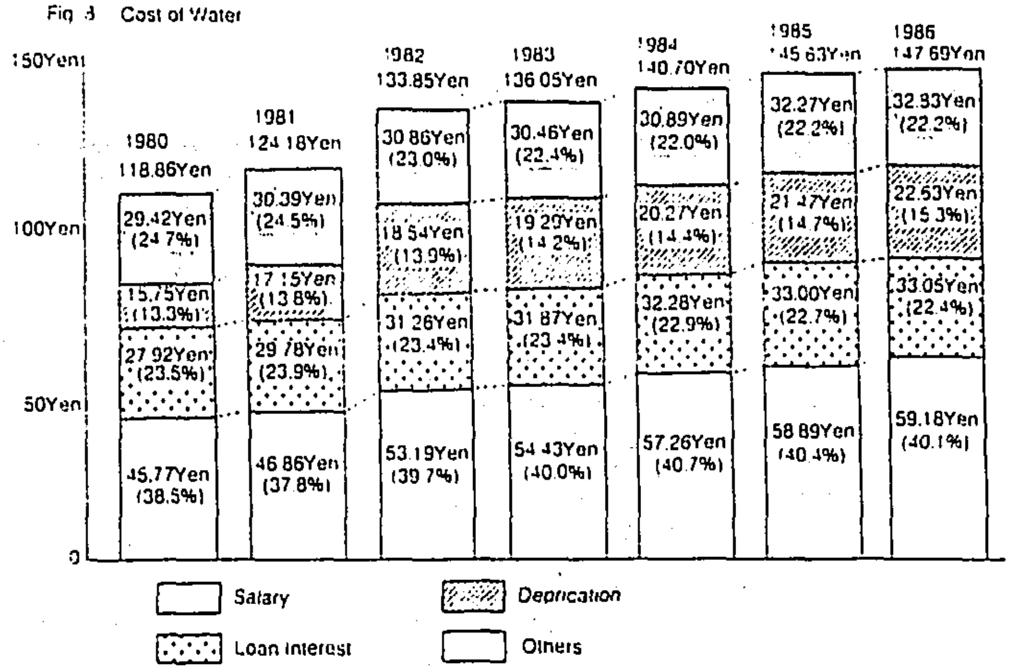



Table-8. Constitutions of Water Cost (unit: Yen/m³)

| Items \ Fiscal year | 1965 | 1970 | 1975 | 1980 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|
| Employee Payment(Yen) | 8.89 | 11.36 | 21.76 | 29.42 | 30.46 | 30.89 | 32.27 | 32.83 |
| Depreciation Account(Yen) | 3.66 | 5.32 | 8.49 | 15.75 | 19.29 | 20.27 | 21.47 | 22.63 |
| Payment of Loan interest(Yen) | 6.04 | 8.68 | 16.59 | 27.92 | 31.87 | 32.28 | 33.00 | 33.05 |
| Others(Yen) | 9.11 | 13.42 | 21.95 | 45.77 | 54.43 | 57.26 | 58.89 | 59.18 |
| Total(Yen) | 27.70 | 38.78 | 68.79 | 118.86 | 136.05 | 140.70 | 145.63 | 147.69 |
| Rate(%) | 40 | 56 | 100 | 173 | 200 | 205 | 212 | 215 |

## 8. Water Charge

Water charge is decided by each water supply body based upon the self-supporting system. So there are some differences of water charges among water supply bodies.

Water charge a household a month was 1,802 yen in 1985 (about US $12) and the proportion in housekeeping account is about 0.7 per cent.

Fig. 9 Water Charge (1985)
(Domestic Use: Yen/20m³/month)

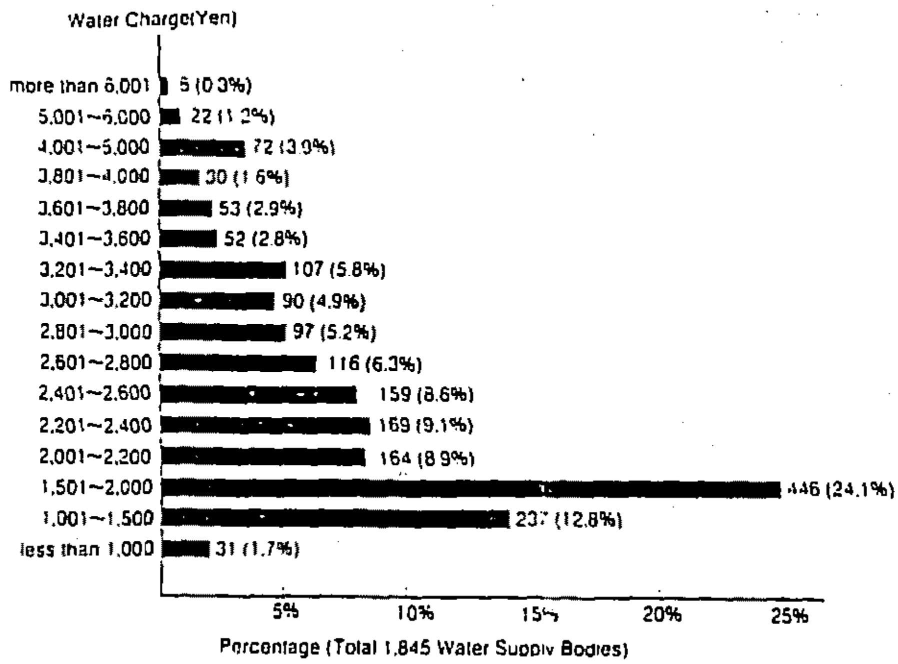



Table-9 Domestic Expense and Water Charge (unit: Yen/family/month)

| Items \ Fiscal year | 1970 | 1975 | 1980 | 1985 | 1986 |
|---|---|---|---|---|---|
| Total Expense (A) (Yen) | 82,792 | 160,475 | 234,946 | 278,592 | 279,799 |
| Water Charge (B) (Yen) | 505 | 831 | 1,294 | 1,802 | 1,901 |
| Percentage (B/A) | 0.6 | 0.5 | 0.6 | 0.6 | 0.7 |

Object: families living in cities where population is more than 50,000

## 9. Government Subsidies to Watrerworks

Based on Waterworks Law, the government of Japan subsidizes some of the waterworks bodies in order to financially aid costly works and promote further development of waterworks.

| Subsidized Works | Subsidy Rate |
|---|---|
| for construction of water resources facilities | 1/3 or 1/2, along with cost and capability of the facilities |
| for construction of long distance (more than 7 km) water conveyance facilities | 1/3 or 1/2, along with cost and capability of the facilities |
| for construction of reorganized waterworks facilities | 1/4 or 1/3, along with cost and character of the reorganization plan |
| for construction of sludge treatment facilities | 1/4 |
| for installation of water examination equipments at regional centers of water quality control | 1/4 |
| for construction of small scale public water supply systems | 1/4, 1/3, 4/10 or 2/3, along with waterworks bodies' financial capability, pipe length, etc. |

## 10. Local Loan

Based on the Local Autonomy Law, a local autonomous entity can float, a local loan for constructing water supply facilities. The following are the conditions of floating loans in fiscal 1987.

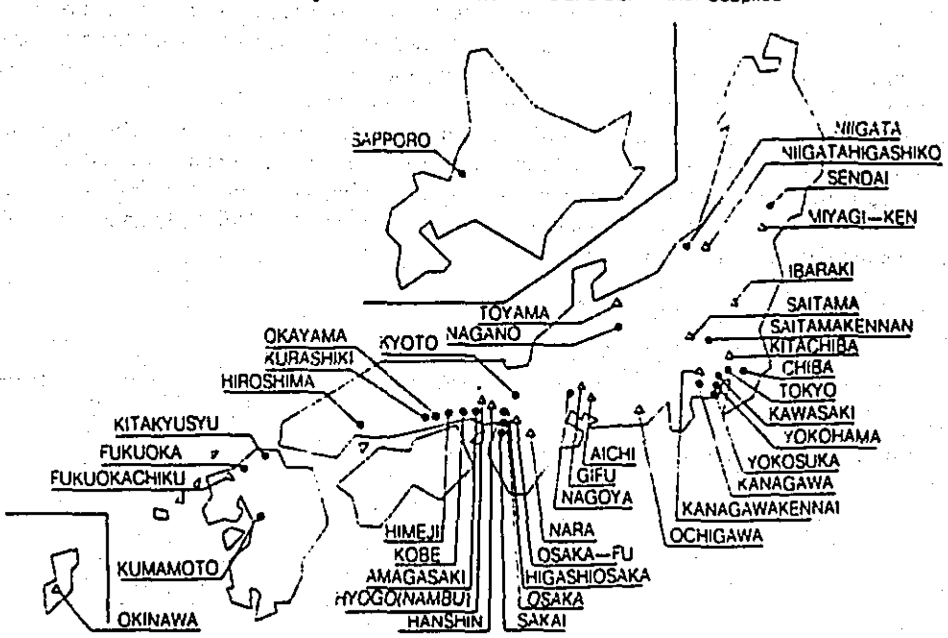
| Condition / Fund Sources | Defering Term of Loan Repayment | Term of Repayment | Ratio of Interest on a Loan | Amount Floated |
|---|---|---|---|---|
| National Fund | 5 years | 30 years | 5.2% | $250 \times 10^9$ yen |
| Public Subscription Funds | 3 or 5 years | 28 years | 5.3% | $255 \times 10^9$ yen |
| | Depending on fund source section | | | |
| Total | | | | $505 \times 10^9$ yen |

The conditions of floating local loans are annually given by Ministry of Home Affairs.

# 11. Planning of Water Supply Systems

Water supply facilities should be constructed to cover the increasing demand of water in accordance with the regioal programs.

Fig. 10. Large Scale Public Waterworks and Bulk Water Supplies




● Water Warks
∴ Bulk Water Supplies

Table-10. Planning of Large Waterworks (unit: $\times 10^3$ $m^3$/day)

| Waterworks | | | | | | Bulk Water Supplies | | |
|---|---|---|---|---|---|---|---|---|
| Name | Planning Year | Maximum Daily Supply | Name | Planning Year | Maximum Daily Supply | Name | Planning Year | Maximum Daily Supply |
| Tokyo | 1990 | 7,479 | Fukuoka | 1989 | 748 | Saitama(Dai-ichi) | 1989 | 2,015 |
| Osaka | 1979 | 2,880 | Sendai | 1996 | 653 | Aichi | 1992 | 2,100 |
| Nagoya | 1981 | 1,423 | Sapporo | 1995 | 970 | Osakafu | 1981 | 2,650 |
| Yokohama | 1980 | 1,780 | Okayama | 1980 | 400 | Kanagawakennai | 1985 | 2,032 |
| Chiba | 1993 | 1,540 | Saitamakennan | 1982 | 445 | Hanshin | 1990 | 1,290 |
| Kanagawa | 1984 | 1,167 | Amagasaki | 1982 | 384 | Miyagi | 1996 | 553 |
| Kyoto | 1985 | 1,050 | Kumamoto | 1990 | 616 | Kitachiba | 1980 | 534 |
| Kawasaki | 1980 | 1,026 | Sakai | 1980 | 455 | Nara | 1987 | 485 |
| Kobe | 1990 | 968 | Kurashiki | 1985 | 322 | Okinawa | 1990 | 578 |
| Kitakyushu | 1983 | 727 | Himeji | 1981 | 320 | Hyogo(Nanbu) | 1990 | 751 |
| Hiroshima | 1995 | 798 | Niigata | 1985 | 330 | | | |

## 12. Public Water Supplies in Future

Water works aim at clean and ample water supply to all people. For this purpose the following are neccesary in future; ①to reduce areas where public water supply is not available, ②to develop new water resources, ③to secure the safety of supplied water and ④to minimize the regional differences of water charges.

In order to achieve these subjects, it is considered a neccesary and effective way to reorganize existing municipally constructed and maintained small water supply systems to large intermunicipal ones which have adequate financial and technological basis. This reorganization should be the perspective for the future public water supplies in Japan.

Available water resources are not infinite. And even if investments and technologies are concentrated to develop new water resources, the areas where water demand exceed the supply might spread, and water charge might become higher and higher.

Therfore, it is important to try to use water rationally in our daily life. Saving water is one of the most effective measures at hand against water shortage.

## [Water Quality Standards in Japan]

| Item | Standards |
|---|---|
| Nitrite nitrogen and Nitrate nitrogen | Max. 10mg/ℓ(as N) |
| Chloride ion Max. | 200mg/ℓ |
| Organic substances(as potassium permanganate consumption) | Max. 10mg/ℓ |
| Total colonies | Max. 100mℓ |
| Coliform group | Not to be detected |
| Cyanide ion | Not to be detected |
| Mercury | Not to be detected |
| Organic phosphate | Not to be detected |
| Copper | Max. 1.0mg/ℓ |
| Iron | Max. 0.3mg/ℓ |
| Manganese | Max. 0.3mg/ℓ |
| Zinc | Max. 1.0mg/ℓ |
| Lead | Max. 0.1mg/ℓ |
| Chromium (hexavalent) | Max. 0.05mg/ℓ |
| Cadmium | Max. 0.01mg/ℓ |
| Arsenic | Max. 0.05mg/ℓ |
| Fluoride | Max. 0.8mg/ℓ |
| Calcium, Magnesium (hardness) | Max. 300mg/ℓ(as $CaCO_3$) |
| Total residue | Max. 500mg/ℓ |
| Phenols | Max. 0.005mg/ℓ |
| Surface-active agents (anionic) | Max. 0.5mg/ℓ |
| pH value | 5.8 to 8.6 |
| Odor | Not to be abnormal |
| Taste | Not to be abnormal |
| Color | Max. 5 degree |
| Turbidity | Max. 2 degree |

# SUPPLEMENTAL MATERIAL

# ENVIRONMENTAL SANITATION IN JAPAN (1988)

Abstruct of "SOLID WASTE MANAGEMENT IN JAPAN (1988)"

Ministry of Health and Welfare
Japan Waste Management Association,
Japan Environmental Sanitation Association,
Japan International Association of Environmental Sanitation

COOPERATION BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY AND
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS MINISTRY OF PUBLIC WORKS
WATER SUPPLY AND ENVIRONMENTAL SANITATION SEMINAR
Jakarta, 27 - 28 February [illegible]

## 1. System of Solid Waste Management

In " THE WASTE DISPOSAL AND PUBLIC CLEANSING LAW", all wastes except radioactives are classified into two categories, those are, INDUSTRIAL and GENERAL (or MUNICIPAL).

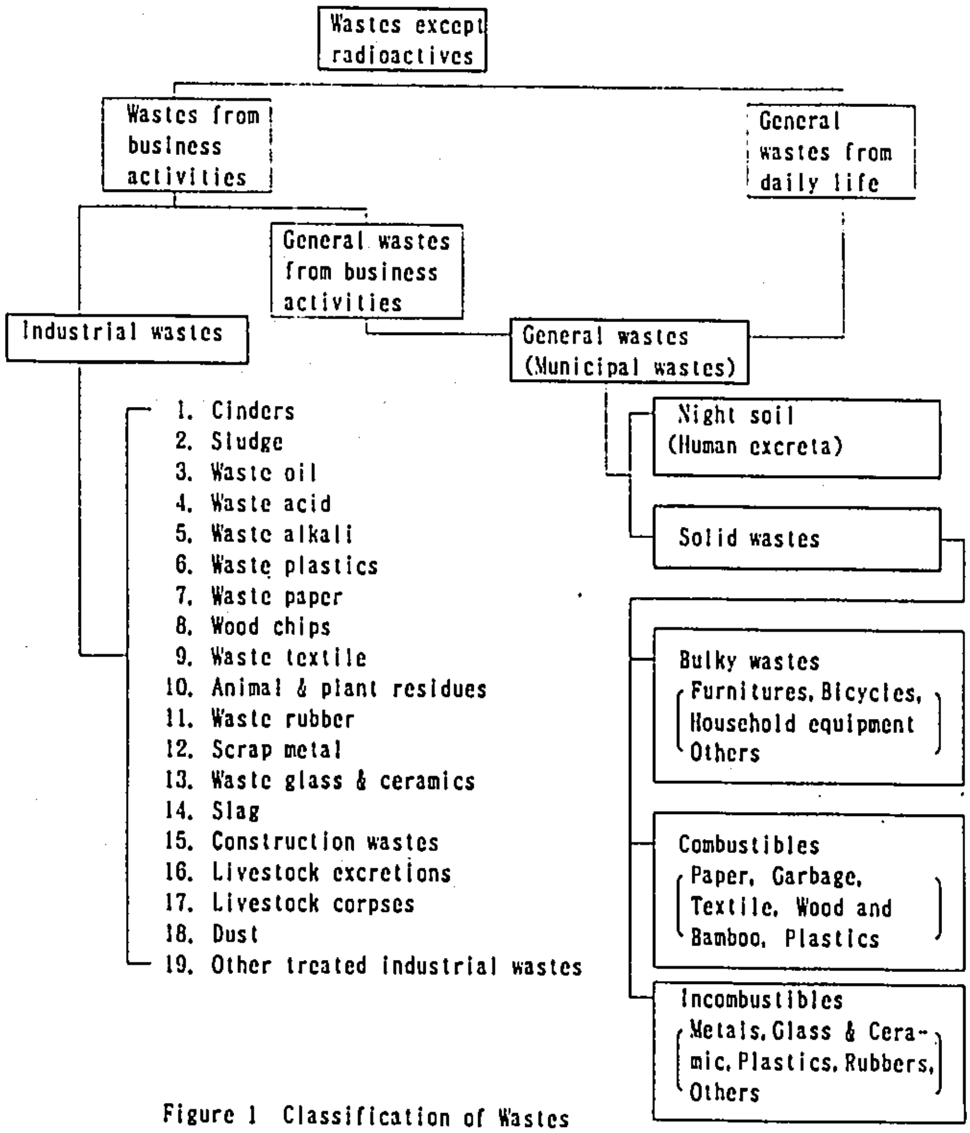



Figure 1 Classification of Wastes

## Duties of the Enterprise

The duties of the enterprise comprise following 3 main objectives.

(1) The first is the appropriate disposal of the wastes generated from the enterprising activity on his own responsibility.

(2) The second is to endeavor to lessen the amount of wastes by reuse of wastes.

(3) The third is to take countermeasures, so as not to impair the appropriate waste treatment of the products or the containers to be manufactured, processed and sold.

## Duties of the Government and Municipalities

The duties of municipal, prefectural and national governments are as follows.

(1) Duties of municipalities

The municipal governments endeavor to propagate the concepts of cleanliness and to excecute waste treatment. They also endeavor to operate the disposal work efficiently, by improving the ability of the staff, constructing disposal facilities and developing operation techniques.

(2) Duties of prefectural governments

The prefectural governments endeavor to give necessary technical advice to the municipalities for carrying out the adequate performance of the duties of municipalities, and endeavor to control the conditions of industrial wastes in the respective prefecture, along with provision of necessary measures.

(3) Duties of the national government

The national government makes plans for the technical research and development on waste disposal, along with furnishing the necessary technical and financial assistance to the municipal and prefectural government, for adequate performance of their duties.

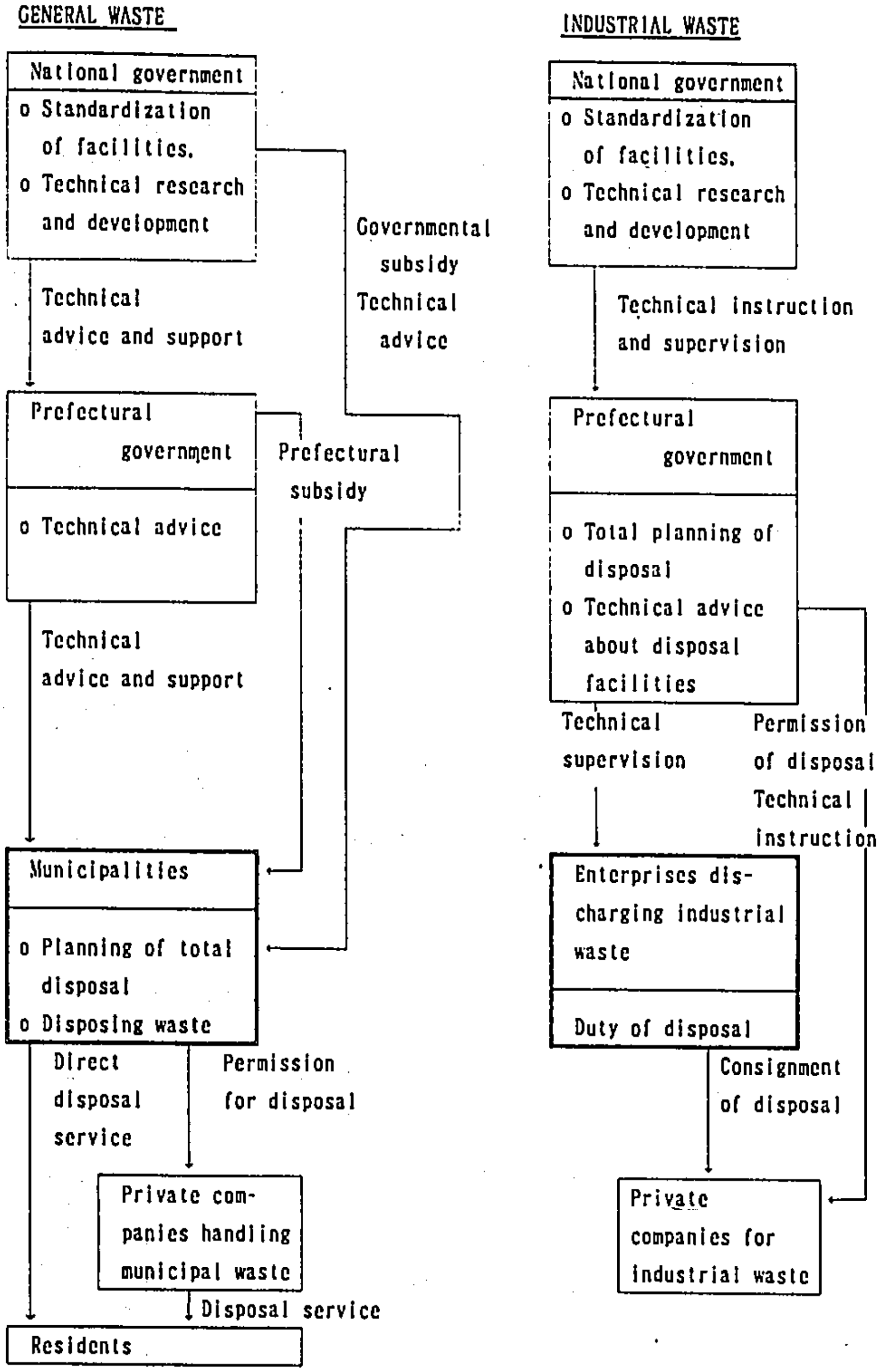



Figure 2 Flow of Waste Management

## 2. Generated Amount

Generated amount of municipal wastes is about 1000g per capita day and total amount of whole country is about 120,000 ton per day. about 80% of which is burnt by incinerators.

Table 1 Annual Changes of Municipal Waste Generation and Treatment

| Fiscal year (※) | | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| Total population(×1000 persons) | | 118,960 | 119,733 | 120,444 | 121,267 |
| Total generated amount (t/day) | | 121,857 | 116,864 | 117,916 | 119,041 |
| Unit amount (g/capita day) | | 1,028 | 980 | 981 | 986 |
| Incineration amount: | t/day | 75,264 | 75,022 | 77,841 | 87,370 |
| | (%) | (65,3) | (67,6) | (69,1) | (70,6) |
| Landfill amount : | t/day | 37,261 | 32,841 | 31,535 | 30,007 |
| | (%) | (32,3) | (29,6) | (28,0) | (26,4) |
| Other amount : | t/day | 2,731 | 3,112 | 3,214 | 3,405 |
| | (%) | (2,3) | (2,8) | (2,9) | (3,0) |

※ Fiscal year (FY) starts in April and ends in next March in Japan.

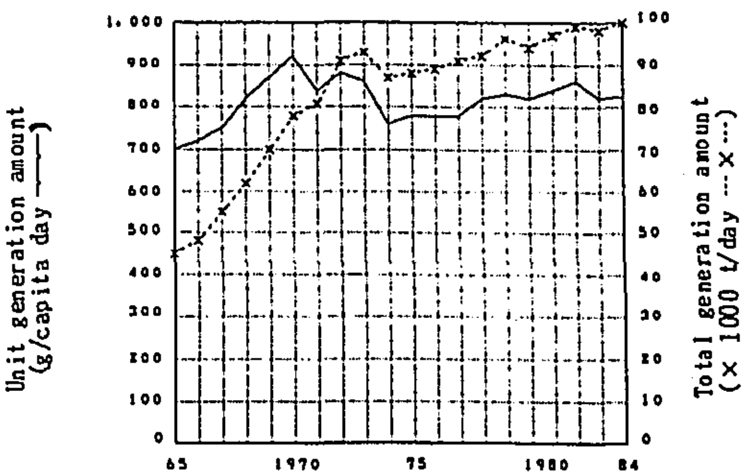



Figure 3 Trend of Total and Unit Generation Amount

## 3. Collection and Disposal

### (1) COLLECTION

Municipalities are responsible for collecting wastes generated from households in their jurisdiction. Domestic wastes collected every day amounts to some 90,000tons, and about 90% of which is collected directly by municipal organizations. Remaining waste is consigned to private contractors specializing in waste disposal or licensed collectors.

Collection forms are classified into two; MIXED collection and SORTED collection. With the former, all types of wastes generated from households are collected in a lump. The latter requires separation of waste at the source level (households)into designated groups (ex. combustibles, incombustibles, useful material and bulky refuse) before collection.

It is said that costs for collection and transportation of municipal wastes account for as much as 70-80% of total waste disposal cost.

### (2) DISPOSAL

Waste is generally disposed by INCINERATION or RECLAMATION (LANDFILL). Incineration functions as means of waste processing to realize volume reduction and stabilization of waste to be landfilled, and has gradually been increasing.

Among other disposal methods, there is composting. But its share is as low as 0.1-0.2%.

The share of incineration is higher in the cities having larger populations, while the share of landfill is higher in smaller cities and rural areas as shown in table 4.

Table 2 Waste Disposal Systems by Population of City (by %, in FY 1979)

| Type of city | 10 largest cities (incl. special districts) | More then 300,000 and less than 500,000 citizens | More than 100,000 and less than 200,000 citizens | Less than 50,000 citizens | Towns, Villages |
|---|---|---|---|---|---|
| Incineration | 66.6 | 64.2 | 46.5 | 40.3 | 33.5 |
| Landfill | 33.2 | 33.4 | 42.6 | 52.5 | 57.3 |
| Resource recovery and others | 0.2 | 2.4 | 10.9 | 7.2 | 9.2 |

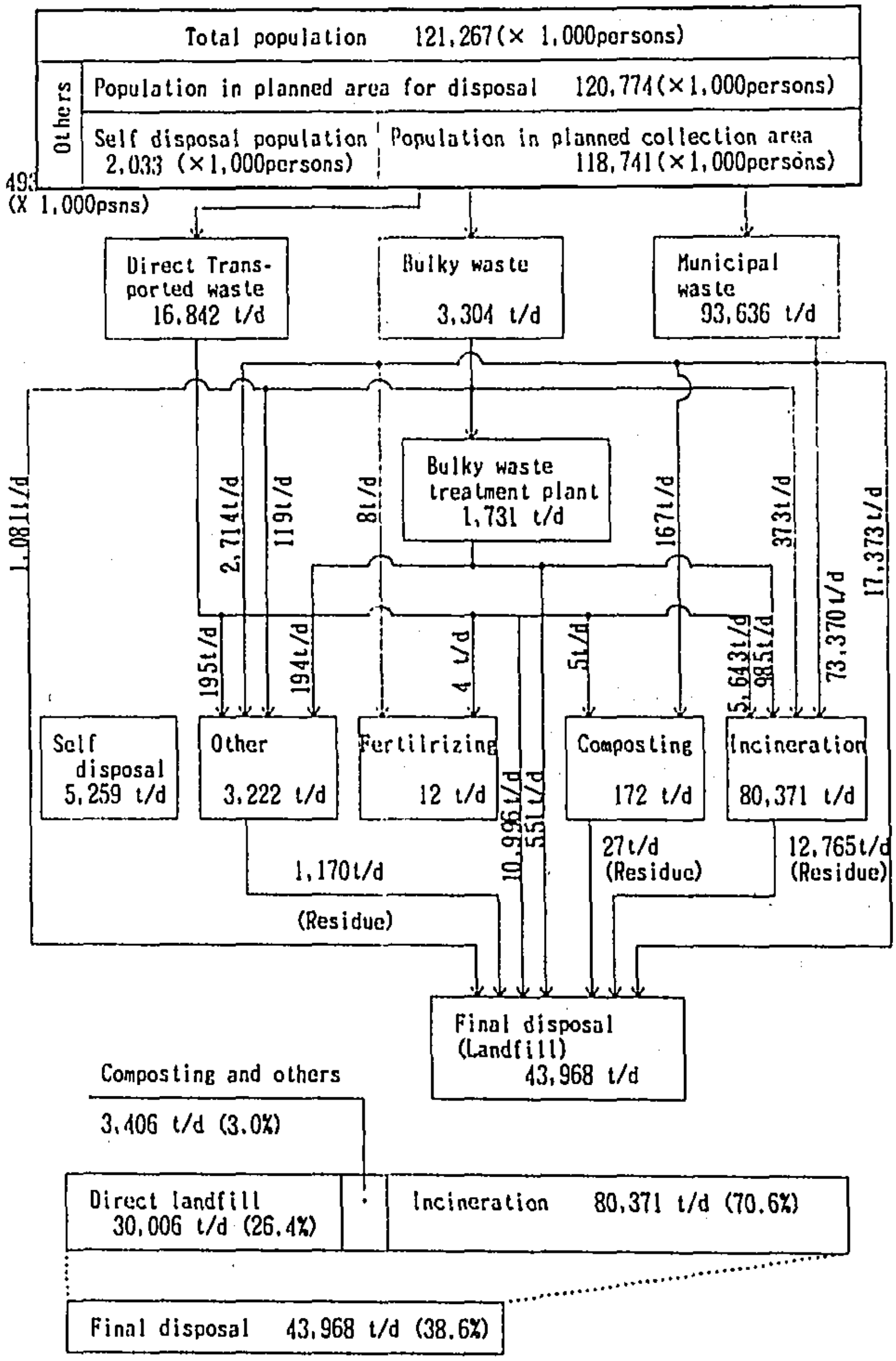



Figure 4 Flow of Solid Waste Disposal (in FY 1985)

## 5.Personnel and Equipment

Number of municipality employees engaging in solid waste management are about 80,000, and about 10,000 private companies with about 80,000 employees also endeavor to do the management.

About 45,000 trucks are carrying solid wastes every day, and the total carrying capacity amounts to 120,000 t/day.

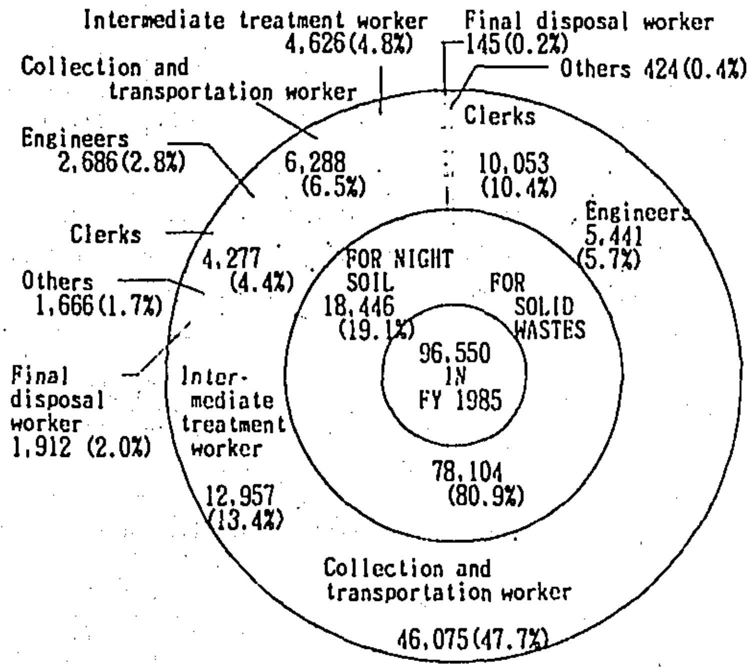



Figure 5 Municipality Employees for Waste Management

Table 3 Companies for Waste Management (in FY 1985)

| Number of private companies | | | | Number of employees | | | |
|---|---|---|---|---|---|---|---|
| Total | For waste only | For night soil only | For both | Total | For nitht soil | For JOKASO* | For waste |
| 10,020 | 5,280 | 3,770 | 976 | 82,493 | 23,077 | 17,042 | 42,014 |

* JOKASO means an individual house disposal tank for night soil and other waste water.

## 7. Finance and Expenditure

Financial source for waste management consists of GENERAL and SPECIAL revenues, and the latter is including govermental and prefectual subsidy, service fee and local governmental loan.

Table 4  Itemized Finance Source of Municipal Waste (in FY 1985, ×million Yen)

| Revenue | Grand total | Special revenue | | | | | | General budget by municipality |
|---|---|---|---|---|---|---|---|---|
| | | Special revenue total | Governmental subsidy | Prefectural subsidy | Service fee | Local government loan | Others | |
| Solid Waste | 1,009,211 | 232,590 | 48,906 | 5,260 | 37,358 | 121,170 | 19,896 | 776,621 |
| Night soil | 345,250 | 96,717 | 12,766 | 2,203 | 52,212 | 22,938 | 6,598 | 248,553 |
| Total | 1,354,461 | 329,307 | 61,672 | 7,463 | 89,570 | 144,108 | 26,494 | 1,025,154 |

Construction cost ratio to total expense amount is about 22%. (That is, 78% is the expenditure for operation and maintenance.) About 49% of operation and maintenance cost is paid for personnel.

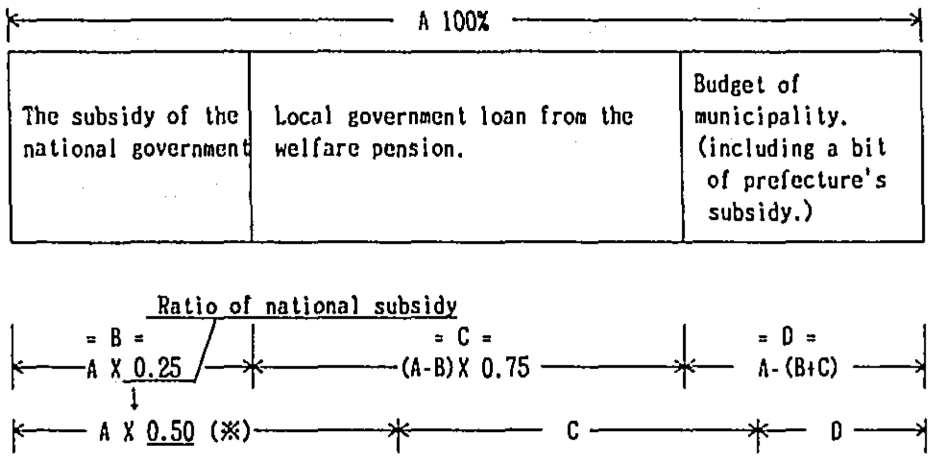
Table 5  Itemized Expenditure of Municipal Waste (in FY 1985, ×million Yen)

| Expenditure | Grand total | Construction / Improvement cost | | | |
|---|---|---|---|---|---|
| | | Construction works | | | Research cost |
| | | Intermediate treatment facility (including incinerator) | Landfill site | Others | |
| Solid waste | 1,009,211 | 164,988 | 50,689 | 12,789 | 4,667 |
| Night soil | 345,250 | 48,041 | 860 | 4,670 | 630 |
| Total | 1,354,461 | 213,029 | 51,549 | 17,459 | 5,297 |

| Expenditure (Continued) | Management cost | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wage & salary | Disposal Fee | | | Purchase of vehicles | Contract fee | Others |
| | | Collection & transport | Intermediate treatment | Final disposal | | | |
| Solid waste | 433,866 | 60,356 | 105,138 | 18,437 | 10,903 | 116,279 | 31,099 |
| Night soil | 93,790 | 10,497 | 81,987 | 3,520 | 1,294 | 80,065 | 19,896 |
| Total | 527,656 | 70,853 | 187,125 | 21,957 | 12,197 | 196,344 | 50,995 |

Table 6 Unit Cost for Operation and Maintenance (in FY 1984)

| Solid waste | | Night soil | |
|---|---|---|---|
| 8,030 Yen/capita・year | 23,501 Yen/t | 6,404 Yen/capita・year | 9,306 Yen/kℓ |




(※)
Ratio of national subsidy for the municipality which the national government designate as strict pollution control area, stipulated by " Special Financial Aid for Pollution Control Law "

Remarks : Half of loan is refunded by local grants (Kofu zei).

Figure 6 Composition of Incinerator Construction Cost

## 8. Outline of Night Soil Treatment

In Japan, night soil or human excreta is treated in four ways, namely, ( i ) by public sewerage systems, (ii) by community sewerage systems, (iii) by JOKASO (individual sewage disposal tanks) or (iv) by night soil treatment plants, where night soil is biochemically treated, chlorinated and discharged into rivers or sea etc., after being collected by vacuum vehicles or honey cars.

Discharge and treatment flow of night soil is shown on Figure 10. About one third of Japanese are provided with public sewerage, another one third use JOKASO and the remaining rely on "vacuum vehicle-night soil treatment plant" systems.

Recently the number of JOKASO has been increasing quite rapidly and steadily along with people's need for a comfortable living environment, especially where sewerage systems are not expected to be constructed. At the end of March, 1986, there were 5.5 million JOKASO and they are increasing by some 300 thousand per year.

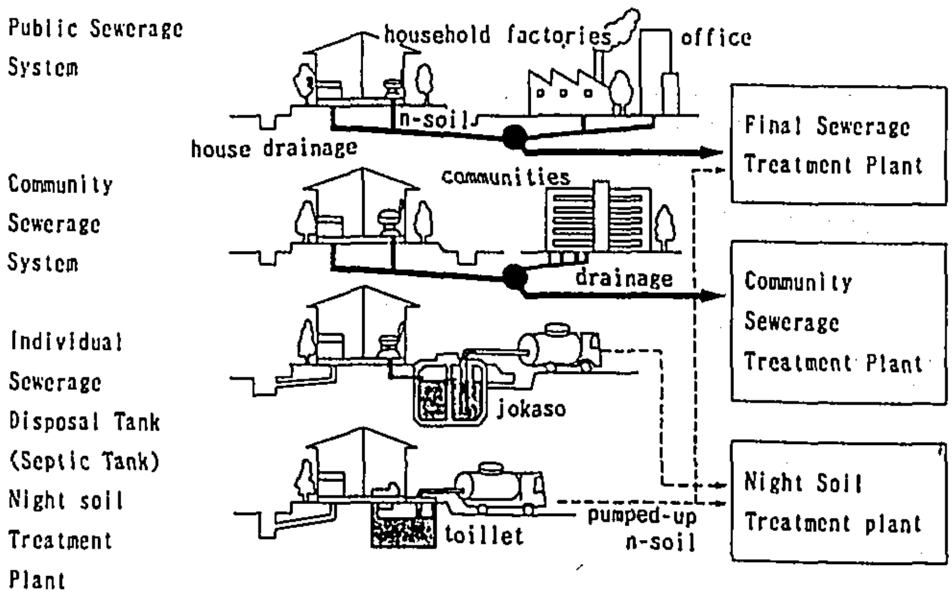



Figure 7 Flow of Night Soil Disposal

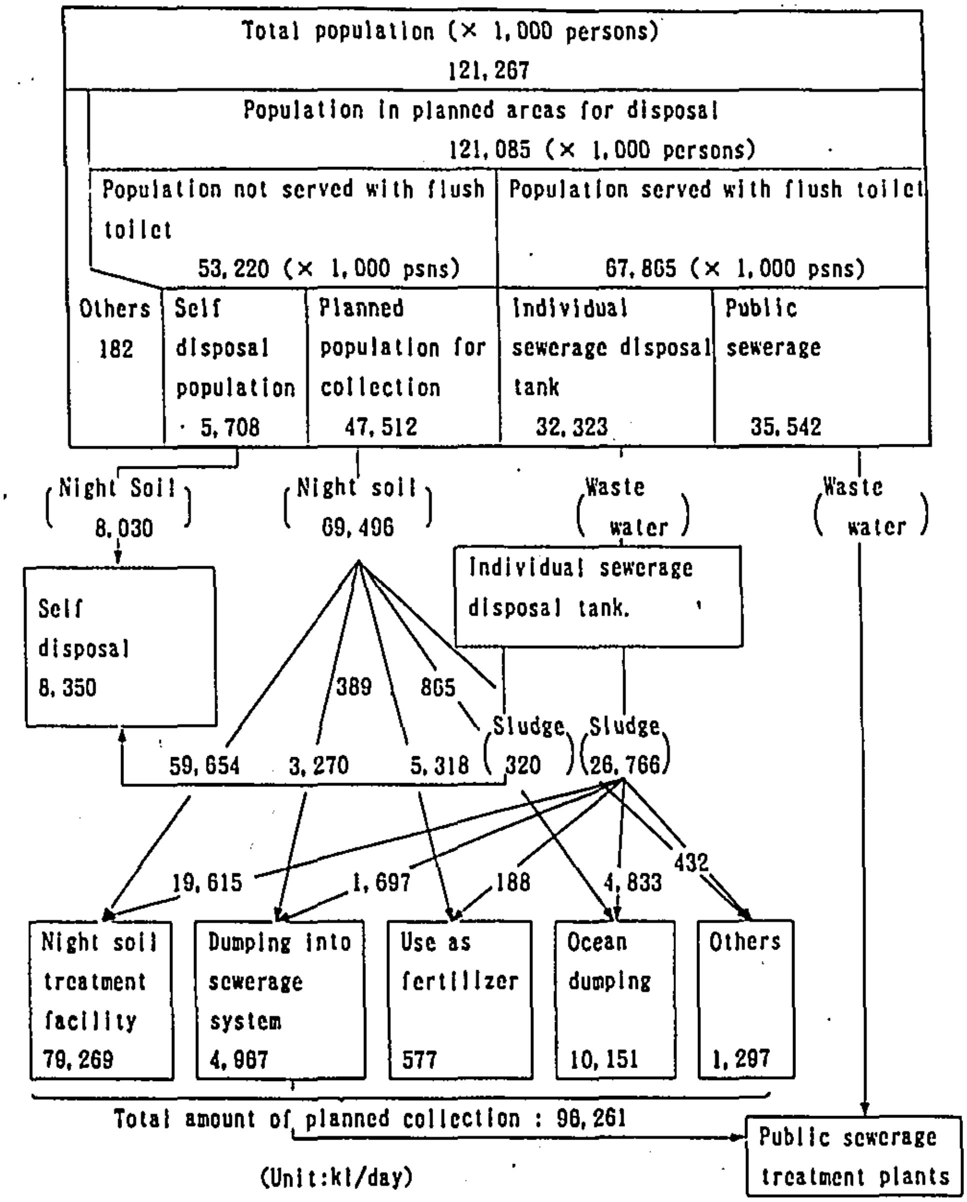



Figure 8 Collection-to-Disposal Flow of Night Soil (In FY 1985)