Night Soil Treatment and Decentralized Wastewater Treatment Systems in Japan

Ministry of the Environment

Night Soil Recycling Systems in the Edo Era

It is believed that agricultural use of night soil in Japan became very popular in the Kamakura Era (1185-1333) as a means of improving agricultural production. During the mid Muromachi Era (1336-1573) it spread throughout the nation, while it really became entrenched as a practice in the Azuchi-Momoyama Era (1573-1603). With the development of urban areas, agricultural use of night soil increasingly spread.

In the Edo Era (1603-1868), owing to the urbanization, not only farmers but also residents in towns tended to construct big night soil storage tanks, so as to offer night soil as suppliers of fertilizer. For collecting night soil, farmers went to towns buying night soil from the residents with money, or exchanging it with vegetables. This kind of night soil recycling mechanism ensured steady supply of night soil which is used as fertilizer necessary for agricultural products. Meanwhile, the products raised by night soil fertilizer were consumed by residents in towns, closer relations between farmers and the residents were formed naturally.

The night soil recycling mechanism continued into the 1960s.

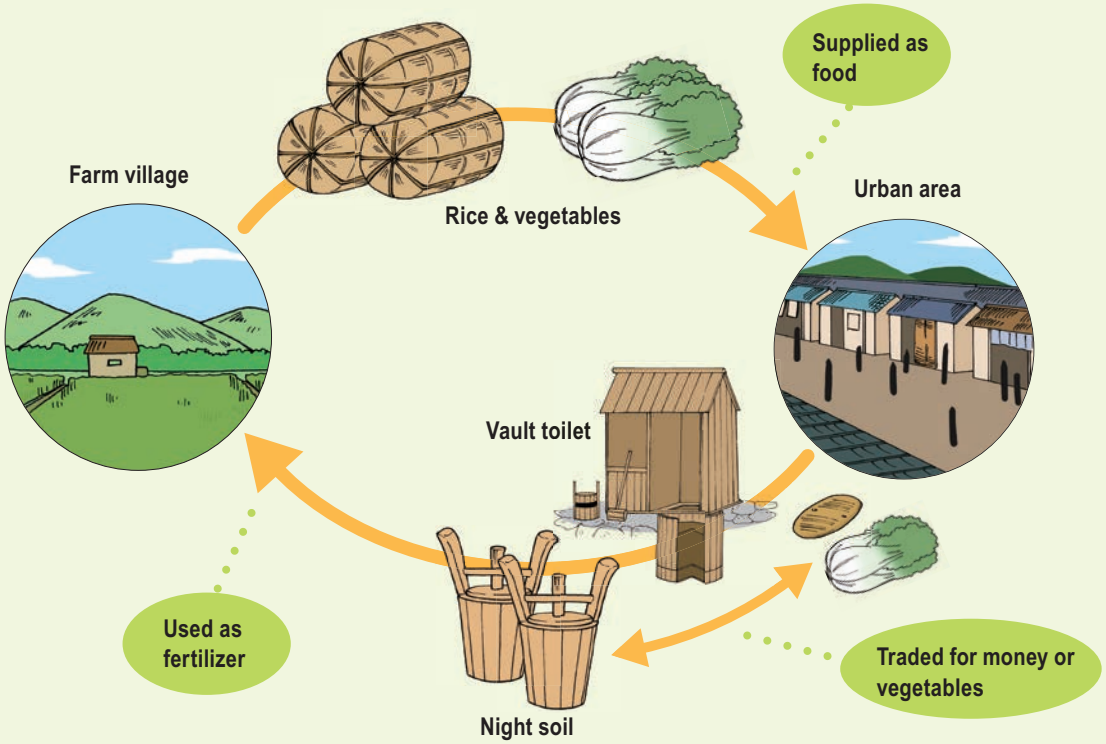


Figure 1 Night soil recycling systems in the Edo Era

Figure 2 The landscape of night soil transportation in the Edo Era(1)

Column 1 Value of night soil in Edo Era(2)

Transportation method	Time of application	Price (per ship)	Price (per oke)	Note
By ship	Spring tillage	3 bu～1 ryo	19-25 mon	1 ship=160 oke,1 da=8 oke, 1 oke=30L 1 ryo=4 bu, 1 bu=4 shu, 1 shu=250 mon Exchange to present curriencies 1 US$＝100JPY＝4 mon
	Autumn tillage	2 bu 2 shu～3 bu	14-19 mon	
	Summer/winter tillage	2 bu 2 shu	14 mon	
By vehicle		1 bu (3.5 da～5 da)	25-36 mon	

Sanitary Treatment of Night Soil

Right after the 2nd World War, the Japanese government had made great effort to maintain a high public health level on the one hand, and to promote a policy of recycling night soil to increase the food production on the other hand.

The emphasis of developing night soil treatment technology at that time was placed on: a) be capable of treating night soil exclusively; b) be capable of killing parasite eggs and pathogenic bacterium; c) making improvement on the odor and the appearance of night soil; d) keeping the fertilizer effect but being free from pathogenic problems. In 1930 the Waste Cleansing Law was revised, from then the municipalities are required to be responsible for the collection and transportation of night soil.

During the rapid economic growth starting from the late 1950s, the traditional night soil recycling systems broke up due to the urbanization and the spread of chemical fertilizer, and night soil turned from 'fertilizer' to 'waste.' Meanwhile, sanitary treatment of the increasing night soil in major cities resulted in a serious social problem. To cope with this problem, municipalities carried out the facility development and the government promoted the technology development on the advanced night soil treatment.

In 1953, the government launched a subsidy program to promote the installation of night soil treatment facilities. And since 1963, night soil treatment facilities have been constructed based on the Waste Treatment Facility Planning.

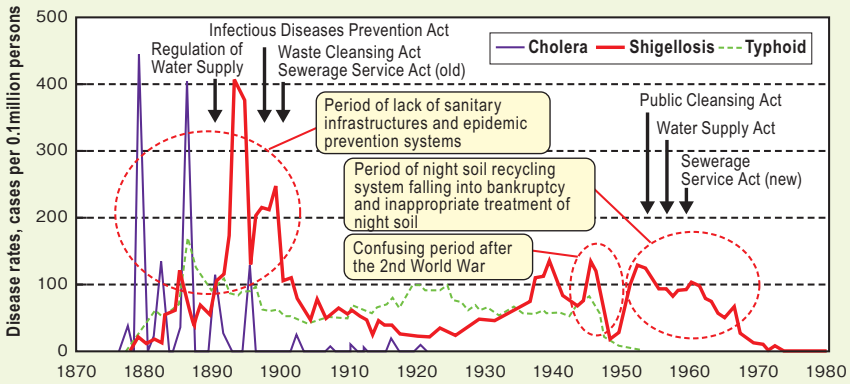


Figure 3 Trends of waterborne disease rates in Japan(3)

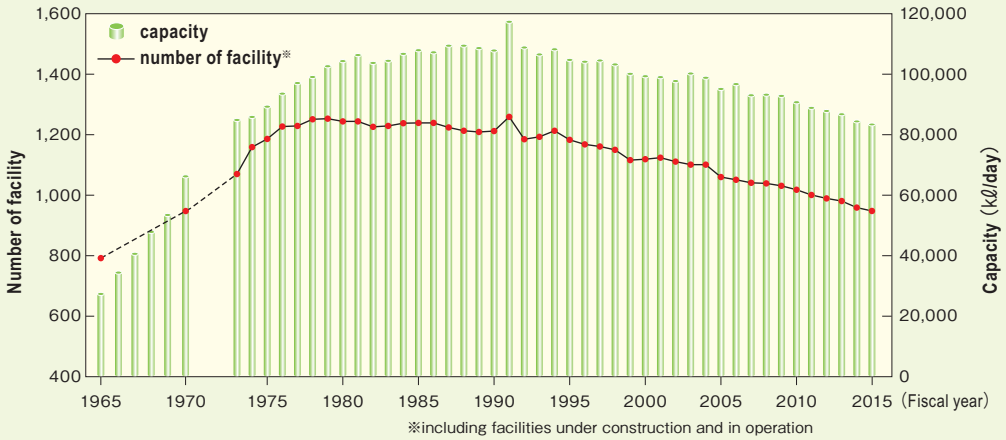


Figure 4 Trends of the number and capacity of night soil treatment facilities(4)

Table 1 Major events in Japanese sanitation history

Year	Event
1879	Regulation on Street Cleansing, Structure of Toilet and Desludging of Toilet
1890	Regulation of Water Supply
1897	Infectious Diseases Prevention Act
1900	Waste Cleansing Act; Sewerage Service Act (old)
1921	Regulation of Flush Toilet Use
1930	Waste Cleansing Act revision
1945	End of the 2nd World War
1950	Recommendation Regarding Resource Scientific Sanitory Treatment of Night Soil (GHQ)
	Building Standard Act
1953	Subsidy Program for Construction of Night Soil Treatment Facilities
1954	Public Cleansing Act
1956	Standard Structure of Night Soil Digester Tank
1957	Water Supply Act
1958	Sewerage Service Act (new)
1967	Basic Law for Environmental Pollution
1970	Waste Disposal and Public Cleansing Act; Water Pollution Control Act
1977	Guidance for Structure of Night Soil Treatment Facilities
1983	Johkasou Act
1987	Subsidy Program for Johkasou Installation
1990	Guidance for Domestic Wastewater Treatment Planning
1993	Basic Environment Act
1997	Night Soil Treatment and Organic Waste Recycling Center
2000	Basic Act for the Promotion of the Recycling-Oriented Society
	Guidance for Treatment Performance of Night Soil Treatment Facilities
	Guidance for Treatment Performance of Night Soil and Johkasou Sludge Advanced Treatment Facilities
2005	Subsidy Program for the Promotion of the Recycling-Oriented Society

The Road to Domestic Wastewater Treatment

During the rapid economic growth of the 1960s, nationwide water pollution caused serious social problems in Japan. It was found that the wastewater discharged from factories and other commercial facilities, the delay in construction of sewerage systems and the untreated gray water from household Tandoku-shori Johkasou, which is designed for treating wastewater from exclusively flush toilets, accounted for this problem. In 1970, the Water Pollution Control Act was enacted to strengthen the regulation on the industrial wastewater, therefore, proportion of the pollutants derived from domestic wastewater had increased comparatively, and became a main source of water pollution in public water bodies.

In 1980s, a new type of small-scale Johkasou known as 'Gappei-shori Johkasou' (referred to as Johkasou thereafter), which can be used for treating both black water and gray water at household level, was developed. The small-scale Johkasou spread rapidly in suburban areas and rural areas which are not suitable for constructing sewerage systems. New installations of Tandoku-shori Johkasou were forbidden from 2001.

With the emergence of small-scale Johaksou, it became possible to take countermeasures against various kinds of water pollution due to domestic wastewater, and this resulted in great improvement in water environment and water recycling in Japan.

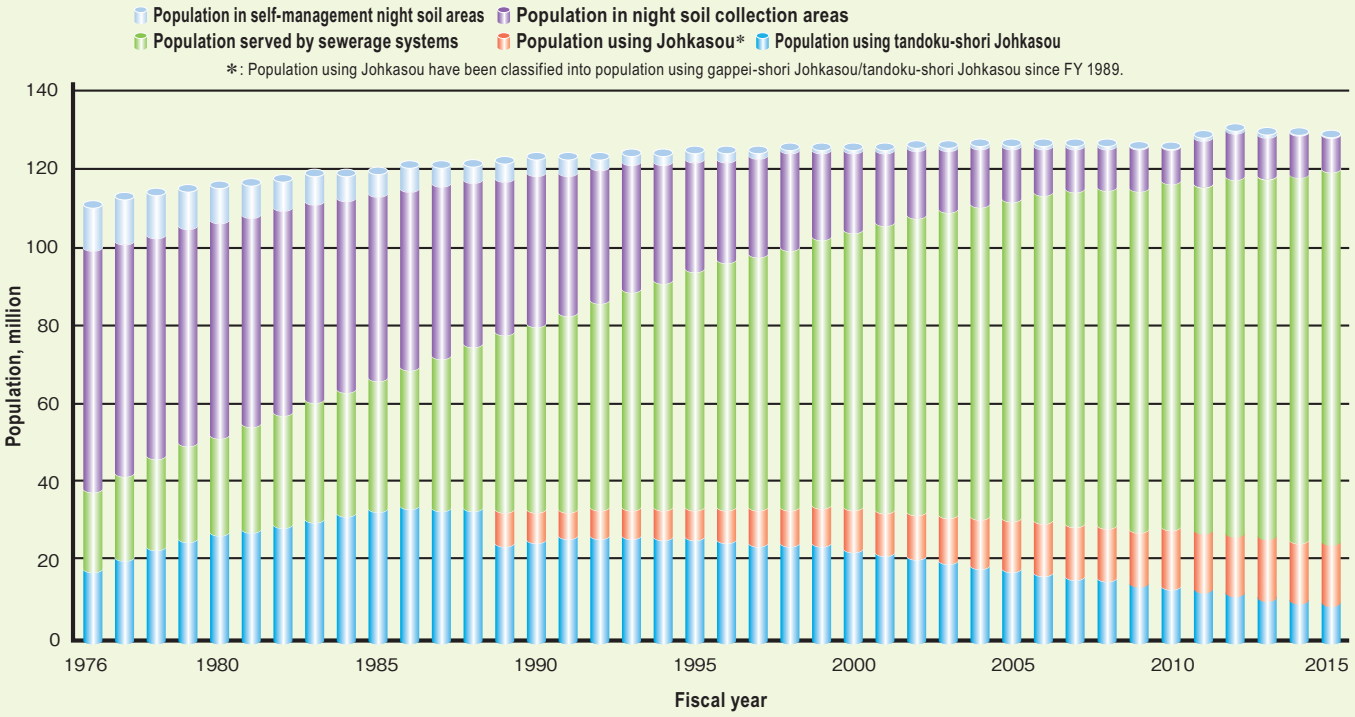


Figure 5 Population trends for night soil treatment and domestic wastewater treatment

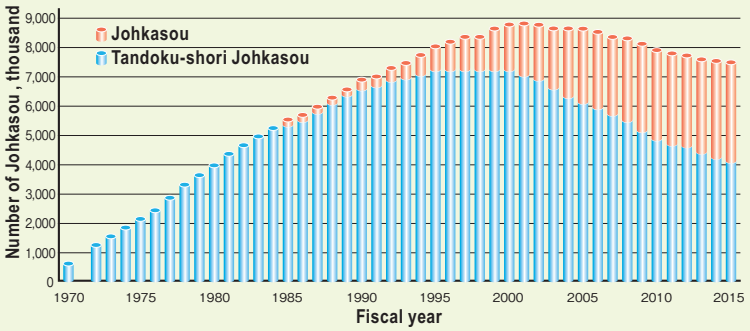


Figure 6 Number and trends of installed Johkasou

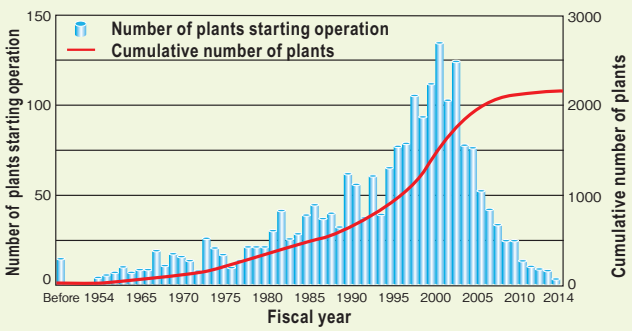


Figure 7 Number and trends of sewerage treatment plants[5]

Column 2 Quantity and quality of domestic wastewater

The daily amount of domestic wastewater is about 200 liters per person in Japan.

Among all kinds of wastewater from houses, kitchen wastewater causes most of the pollutant loads. The next factors are the wastewater from toilets, and then the wastewater from washing and bathing.

All the wastewater from houses is called 'domestic wastewater.'

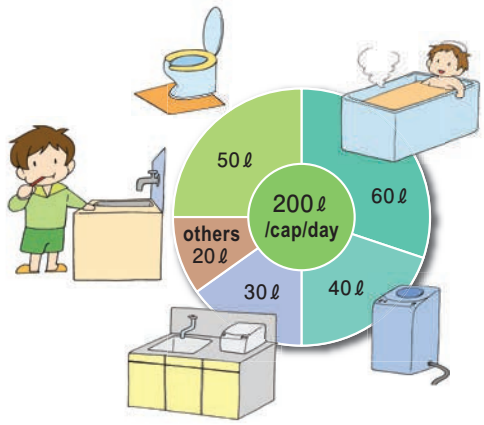


Figure 8 Daily amount of domestic wastewater

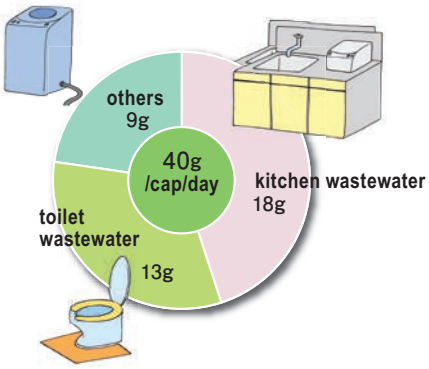


Figure 9 Pollutant loads (BOD) of domestic wastewater

Kitchen wastewater accounts for about 45% of the total pollutant loads of domestic wastewater, because it contains lots of fat and oil components.

The amount of fresh water needed for diluting 100mℓ of liquid kitchen wastes to maintain a survivable environment (in terms of BOD 5mg/ℓ or lower) for fishes is shown in Figure 10.

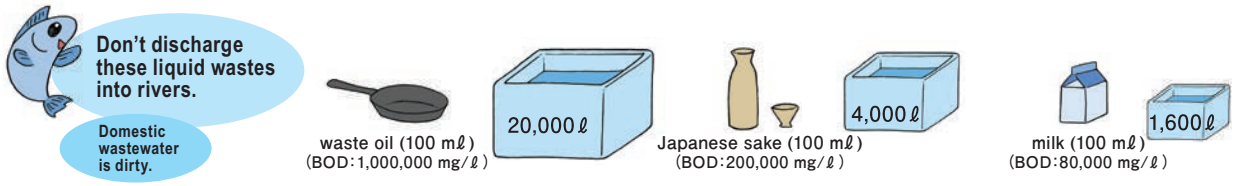


Figure 10 Examples of liquid kitchen wastes with high pollutant loads

Column 3 Effect of environmental improvement by Johaksou installation

A road gully in tandoku-shori Johkasou installation area in 1970s
(where whitish sludge was attached to)

A road gully in Johaksou installation area in 1990s
(where clear water was flowing)

Night Soil Treatment and Domestic Wastewater Treatment Systems in Japan

There are three major domestic wastewater treatment systems in Japan, which can be classified into "Sewerage system," "Rural sewerage system" and "Johkasou system," according to the type of wastewater treated, the facility size and administrative support. Apart from these systems, there are two systems for night soil treatment: “Tandoku-shori Johkasou” and “Night soil storage tank.” New installations of Tandoku-shori Johkasou were forbidden from 2001, and night soil storage tanks are no longer installed and are gradually being phased out.

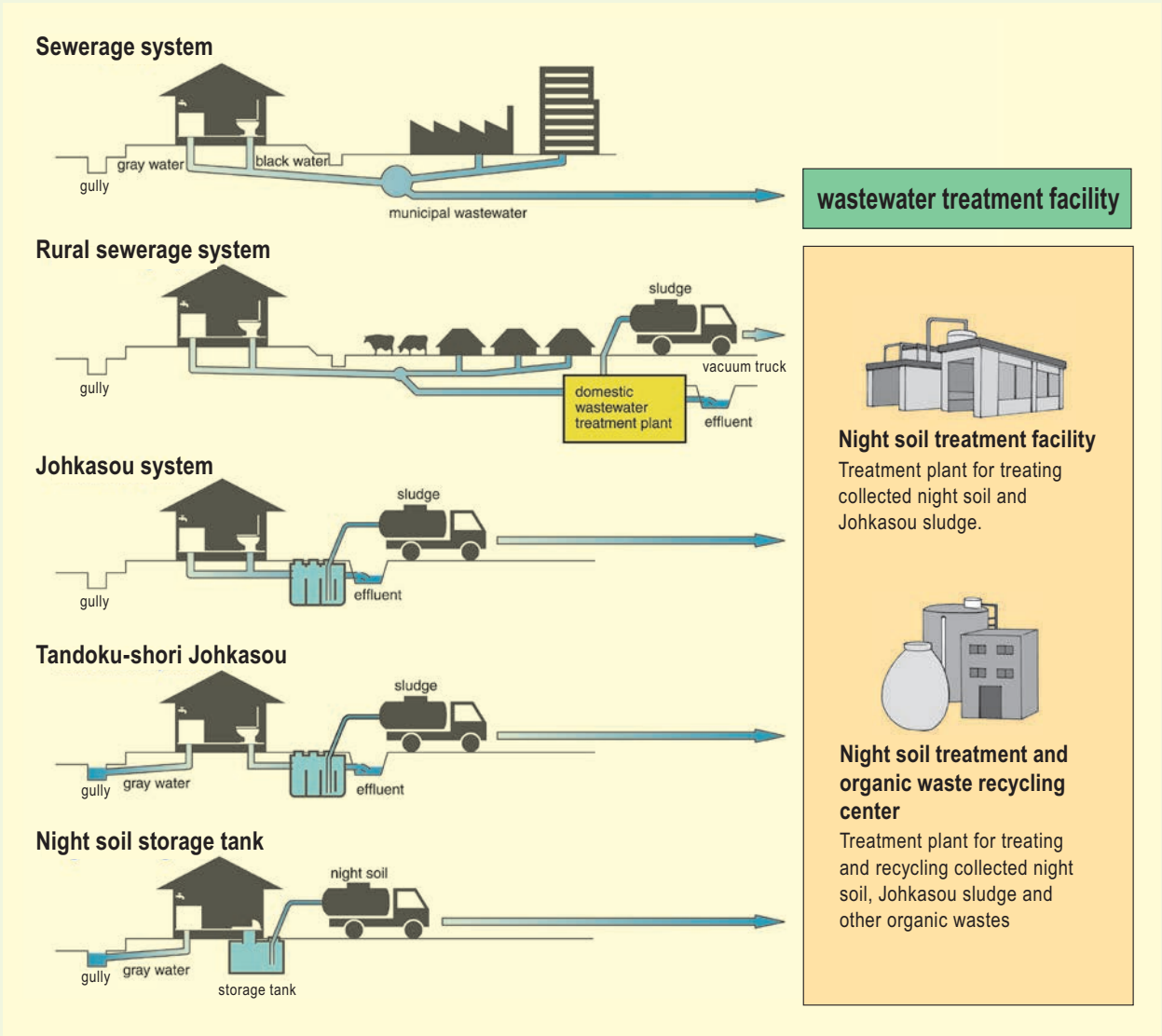


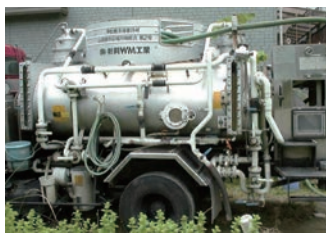
Figure 11 Major night soil and domestic wastewater treatment systems in Japan

Column 4 Evolution of vehicles used for night soil transportation

A two-wheeled cart in 1950s[6]

The first small vacuum truck in 1960s[6]

A normal vacuum truck



A vacuum truck with concentrating function

Centralized Treatment and Decentralized Treatment Systems

To efficiently promote countermeasures for domestic wastewater, several kinds of domestic wastewater treatment facilities have been constructed in accordance with regional characteristics in Japan. In urban areas and villages with high population density, centralized systems such as sewerage systems and rural sewerage systems are planned and constructed; decentralized systems such as Johkasou systems are constructed in rural areas with low population density.

Sewerage systems are usually constructed in urban areas, where houses, factories and office buildings are concentrated, collecting wastewater through a piping network system and treating the wastewater in a centralized manner at wastewater treatment plants that are usually located in downstream areas of rivers or near the seacoast. A sewerage system is usually designed to serve tens of thousands to several hundreds of thousands people and includes the treatment of industrial wastewater and rainwater.

A rural sewerage system is introduced primarily in farming villages for domestic wastewater treatment. Under this system, wastewater from each home is collected through a piping system and then delivered to a centralized treatment plant for treatment.

Johkasou systems are generally divided into 'small-scale Johkasou,' which are designed for treatment of the domestic wastewater of individual houses,and 'medium to large scale Johkasou', which are designed for treatment of the domestic wastewater of housing complexes, hospitals and other commercial facilities. However, more than 90% of installed Johkasou are small-scale Johkasou.

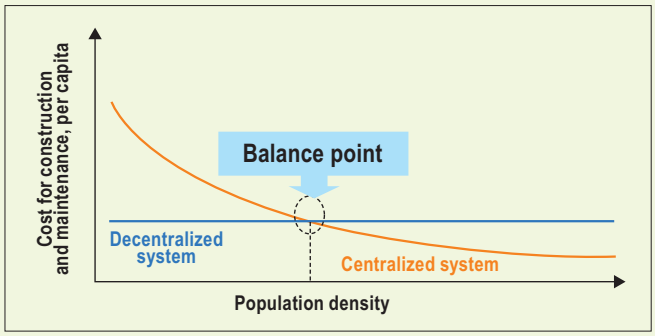


Figure 12 Comparison of decentralized/centralized system costs

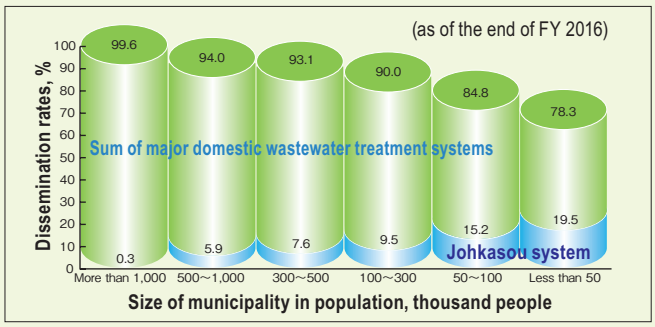


Figure 13 Dissemination rates of domestic wastewater treatment systems

Figure 14 Schematic of decentralized/centralized systems

Table 2 Outline of major domestic wastewater treatment systems

Type of system or facility	Sewerage system	Rural sewerage system	Johkasou system	Night soil treatment facility
Purpose	Maintain the water quality of natural water resources and improve the living environment by collectively treating night soil,miscellaneous domestic wastewater,industrial wastewater and rainwater.	Maintain agricultural water/wastewater clean/safe and improve the living environment by collectively treating night soil,miscellaneous domestic wastewater and rainwater.	Maintain good water quality of public water bodies and a healthy living environment and promote public health by treating night soil and miscellaneous domestic wastewater onsite.	Maintain healthy living environment and promote public health by treating collected night soil and Johkasou sludge.
Responsible agency	Municipalities	Municipalities	Individuals,communities and municipalities	Municipalities
Applicable district	Mainly urban areas	Agricultural villages within specified districts where agriculture is being promoted	Districts where Johkasou installations are promoted	——
Applicable population	Approx. 10,000 or more	Up to about 1,000	——	——
Applicable wastewater	Night soil (flush toilet wastewater) miscellaneous domestic wastewater, industrial wastewater and rainwater	Night soil (flush toilet wastewater), miscellaneous domestic wastewater and rainwater	Night soil (flush toilet wastewater) and miscellaneous domestic wastewater	Collected night soil and Johkasou sludge
Construction period	Approx. 5 years	3~5 years	Approx.1 week up to 1 year	2~3 years
Competent authority	Ministry of Land, Infrastructure, Transport and Tourism	Ministry of Agriculture,Forestry and Fisheries	Ministry of the Environment	Ministry of the Environment

Advantages of Johkasou As Decentralized System

As small-scale Johkasou can be installed on a household level and treat and discharge wastewater locally, these have remarkable advantages compared to sewerage systems from the perspective of protecting the local aquatic environment and offering better cost-benefit performance.

Advantages of Johkasou systems are:

ⅰ. Low initial investment cost

As small-scale Johkasou are mass-produced, the price of Johkasou can be maintained at an acceptable level for individuals or households. A Johkasou can be installed in a small, unused space.

ⅱ. Little topographic limitation, short installation time and early realization of the effects

As a small-scale Johkasou can be installed in a small, spare space equivalent of a parking spot and the inflow pipes are short, there are few topographic limitations when it comes to the installation of small-scale Johkasou. It takes only a week for a typical installation. Moreover, when the Johkasou begins functioning, its effect on wastewater treatment is evident immediately.

ⅲ. Invaluable contribution to maintaining sufficient water amount in small rivers and aquatic environments near inhabited areas

As the effluent of Johkasou is discharged onsite to surrounding small rivers through drainpipes, it contributes to maintaining sufficient amounts of water in small rivers, enhancing water circulation in local areas, and does not damage the natural scenery.

ⅳ. Treated water and sludge from Johkasou are easy to reuse

As Johkasou are basically designed to treat domestic wastewater from individual houses, there are few toxic substances in Johkasou-treated water and sludge. This makes possible to reuse these substances for various purposes.

ⅴ. Less vulnerable to earthquakes and other disasters

When earthquakes or other disasters strike, a Johkasou can start functioning again very soon, as it has neither a complicated piping system nor enormous mechanical apparatus.

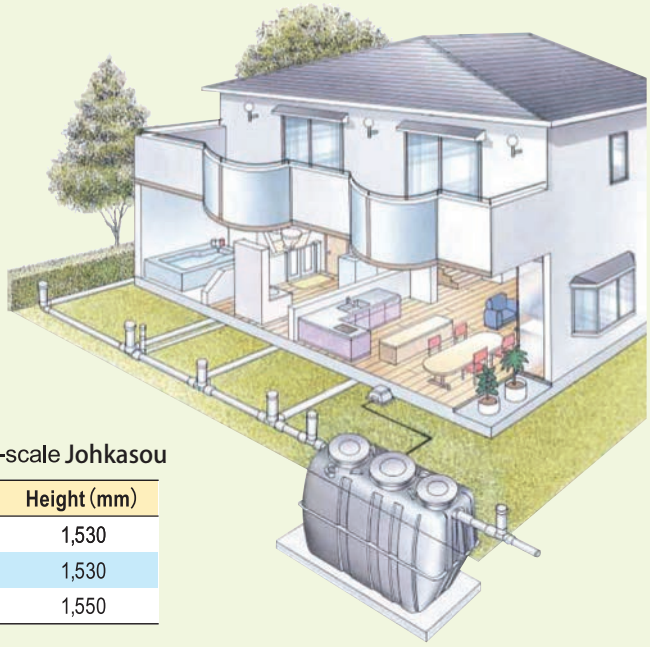
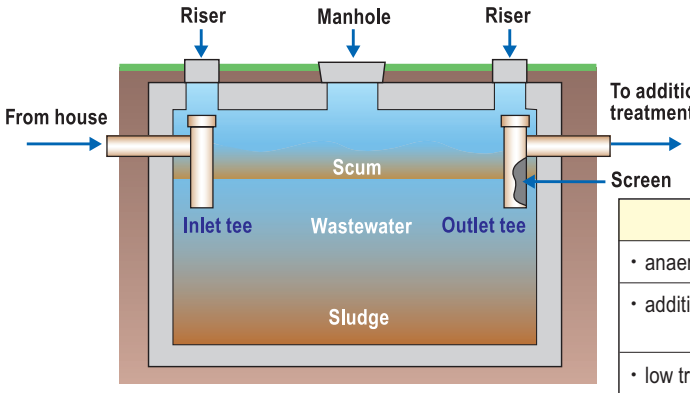


Table 3 An example of dimensions of small-scale Johkasou

	Width (mm)	Length (mm)	Height (mm)
5 PE	980	1,580	1,530
7 PE	980	2,120	1,530
10 PE	1,200	2,790	1,550

Column 5 Decentralized system overseas: Septic Tank



In other countries, septic tanks are installed for domestic wastewater treatment. In the United States, effluent from septic tanks are usually further treated through a drainfield.

Differences between septic tanks and Johkasou

Septic tank	Johkasou
・anaerobic treatment	・anaerobic / aerobic treatment
・additional treatment is necessary	・effluent can be discharged on-site to public water
・low treatment performance (low BOD removal ratio)	・high treatment performance (90% or more BOD removal ratio). ・nitrogen and /or phosphorus removal types are available.

Treatment Principles and Types of Johkasou

Johkasou are designed for treating both black water and gray water discharged from houses. The contaminants contained in wastewater are broken down biochemically by the catabolism of microorganisms such as bacteria and metazoan organisms. Johkasou are designed to maximize the purifying function of microorganisms, and have solid-liquid separation function, sludge storage function and disinfection function.

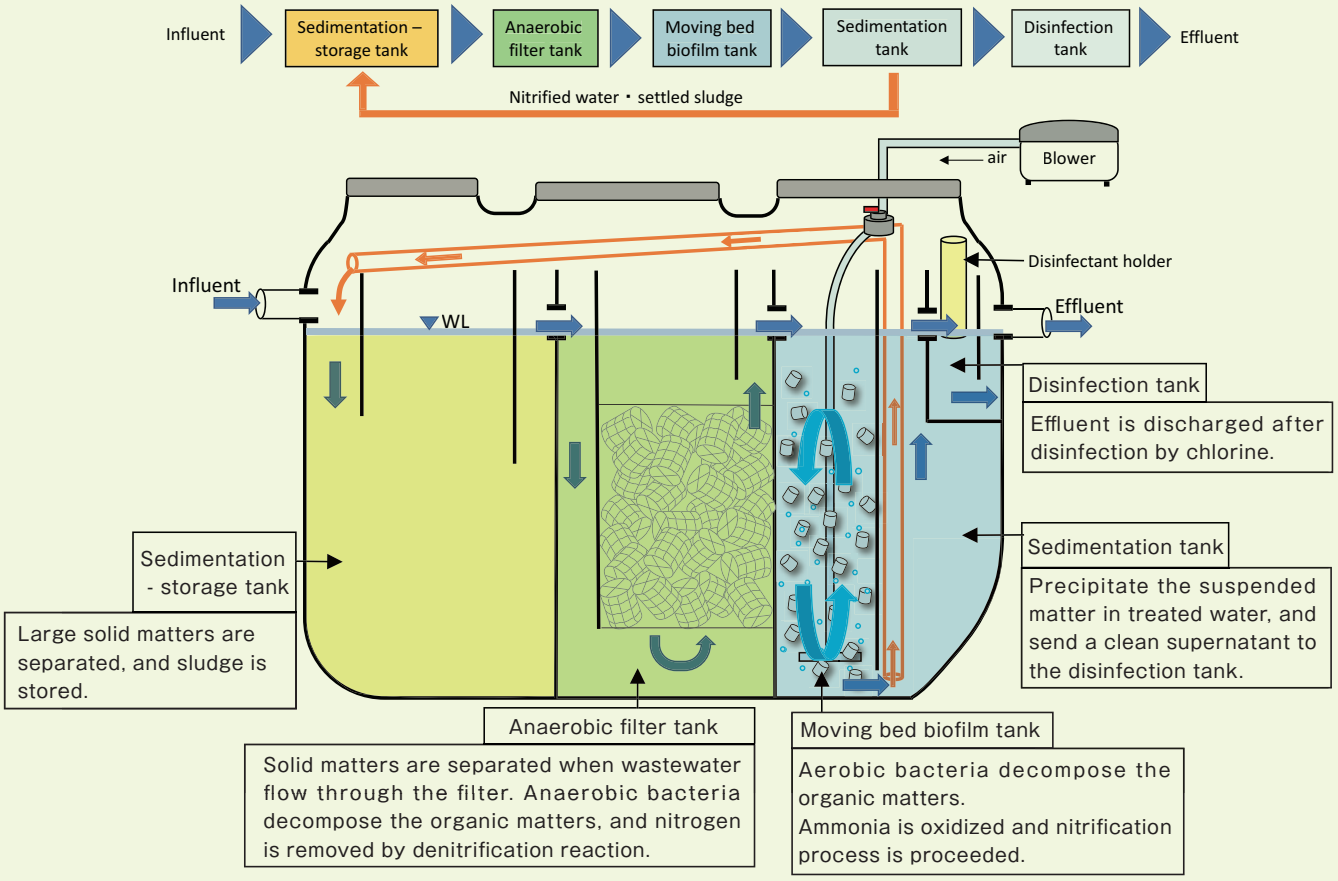
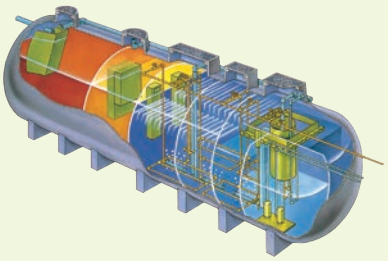


Figure 15 Example of Structure and treatment principle of Johkasou

The capacity, the treatment process and the material of Johkasou are selectable, depending on the usage of the building, quantity and quality of wastewater to be treated, and the regulation issues of discharge areas. However, Johkasou are usually classified by the capacity in terms of number of users for design, or people equivalent (PE).

- Small-scale Johkasou: Johkasou used for individual household and small scale wastewater treatment with capacity of 5 to 50 PE, or average amount of wastewater less than 10 m^3/day. Most small-scale Johkasou are made of plastics such as FRP (fiberglass reinforced plastic) or DCPD (Dicyclopentadiene) at factories.
- Medium-scale Johkasou: Johaksou used for medium-scale wastewater treatment with capacity of 51 to 500 PE, or average amount of wastewater less than 100 m^3/day. Medium-scale Johkasou are made of FRP at factories, or are built of reinforced concrete (RC) at sites of installation.
- Large-scale Johkasou: Johaksou used for large-scale wastewater treatment with capacity of 501 PE or more, or average amount of wastewater more than 100 m^3/day. Large-scale Johkasou are mainly built of reinforced concrete (RC) at sites of installation.

Small-scale Johkasou (FRP-made)



Medium-scale Johkasou (FRP-made)

Large-scale Johkasou (RC-made)

Legislative Infrastructure Underpinning Johkasou Systems

Johkasou Act

The purpose of the Johkasou Act is to promote the appropriate treatment of domestic wastewater, to maintain good water quality of public water bodies and a healthy living environment, and to improve public health via Johkasou systems.

To achieve this purpose, it is essential to strengthen regulations at each stage: manufacturing, installation, operation and maintenance, as well as desludging of Johkasou. This requires a clear understanding of the people who engage in the Johkasou businesses and the business itself, including thoroughly defining the responsibilities of concerned individuals and ensuring that they are professionally certified. The Johkasou Act provides qualifications for Johkasou installation workers and Johkasou operators, as well as for registration and licensing of systems for Johkasou businesses, installation, operation and maintenance, and desludging. Furthermore, the governors and the mayors are authorized to advise and instruct Johkasou managers and Johkasou vendors to improve the Johkasou treatment performance when malfunction is recognized through legal inspections.

The relations among administrative authorities, Johkasou users (Johkasou managers) and vendors are shown as following.

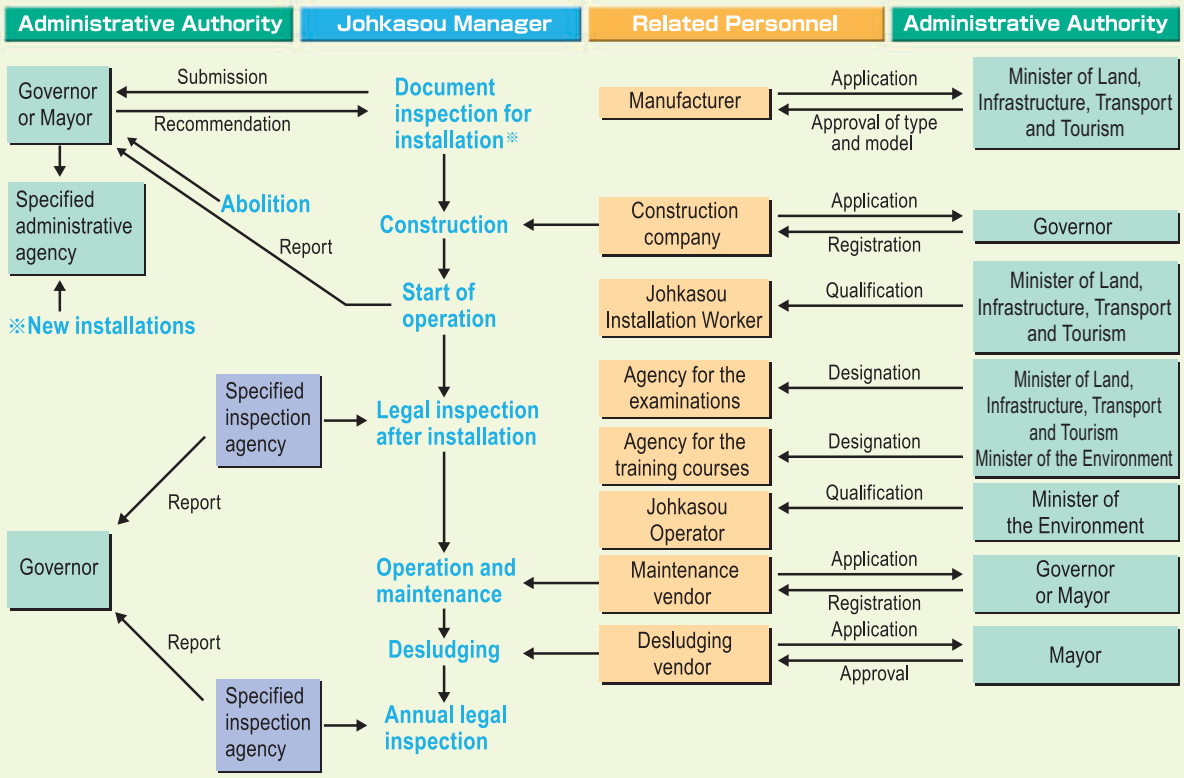


Figure 16 Framework of Johkasou Act

Table 4 Contents of Johkasou Act

Chapter 1 General Rules (Article 1-4)	Chapter 7 Johkasou Installation Worker (Article 42-44)
Chapter 2 Installation of Johkasou (Article 5-7)	Chapter 8 Johkasou Operator (Article 45-47)
Chapter 3 Maintenance and Desludging of Johkasou (Article 8-12)	Chapter 9 Registration of Johkasou O/M Vendor
Chapter 4 Approval of Johkasou Type (Article 13-20)	by Regulations (Article 48)
Chapter 5 Registration for Johkasou Installation Business (Article 21-34)	Chapter 10 Others (Article 49-58)
Chapter 6 Approval for Johkasou Desludging Business (Article 35-41)	Chapter 11 Penalties (Article 59-68)

Related Laws

A Johkasou that can treat domestic wastewater and discharge effluent free of sanitary problems should be installed when installing a flush toilet under the Building Standard Law, unless the wastewater is discharged to sewerage systems. The Building Standard Act and its Enforcement Ordinance stipulate details pertaining to Johkasou structures, the procedure of document recognition for Johkasou installation, and the relation between treatment performance and areas of installation in relation to the Johkasou size in terms of PE. Johkasou installation plans and transportation of sludge from Johkasou should be carried out in accordance with the Waste Disposal and Public Cleansing Act.

A Johkasou over a certain scale should comply with the regulation of effluent standards set under the Water Pollution Control Act and related regulations.

Structure and Treatment Performance of Johkasou

The structure of Johkasou should either be in compliance with the structure designated by the Minister of Land, Infrastructure, Transport and Tourism (known as standard structure type), or a structure certified by this Minister (known as certified structure type).

The structure and the volume for each unit equipment of standard structure types were firstly established in 1969 as a nationwide standard in a notice issued by the then Ministry of Construction. It was subsequently revised several times; a recent edition being called 'Structural Methods Stipulated by the Minister of Construction' was made on July 2000. Structural specifications for Tandoku-shori Johkasou for individual households were deleted during the revision. The latest edition revised in 2006 is shown in Table 5.

Although most of the household Johkasou that had been installed up until several years ago were the standard structure types, the certified structure types became popular having a share over 90 percent due to the rapid development of Johkasou technology.

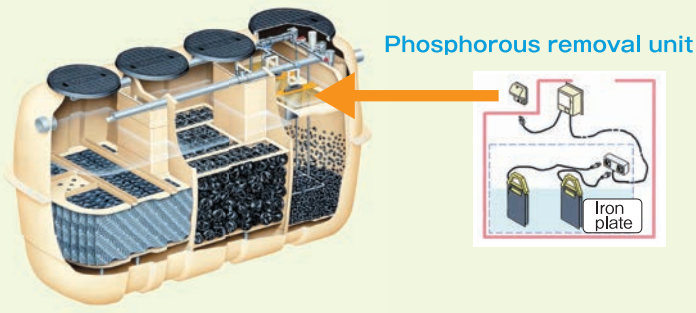
Johkasou can be classified into three types depending on its treatment performance.

- BOD removal types (Effluent BOD ≤ 20mg/ℓ)
- Nitrogen or/and phosphorous removal types (Effluent BOD ≤ 20mg/ℓ, T-N ≤ 20mg/ℓ, T-P ≤ 1mg/ℓ)
- Membrane Johkasou (Effluent BOD ≤ 5mg/ℓ)

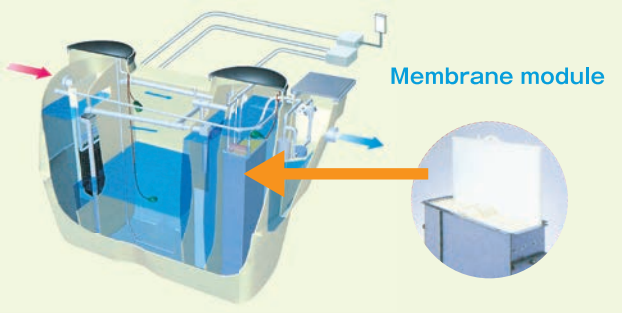
Table 5 Outline of Structural Standards for Johkasou

Class	Type of treatment	Treatment process	Number of users for design (5 50 100 200 500 2000 5000)	BOD removal rate	Treatment performance: Effluent quality (mg/ℓ) BOD	COD	T-N	T-P
1	Combined domestic wastewater treatment	Separation-contact aeration process		90% or more	20 or less	—	—	—
		Anaerobic filter-contact aeration process					—	—
		Denitrification type anaerobic filter-contact aeration process					20 or less	—
4	Flush toilet wastewater treatment	Septic tank process		55% or more	120 or less	—	—	—
5		Land infiltration process		SS: 55% or more	SS: 250 or less	—	—	—
6	Combined domestic wastewater treatment	Rotating biological contactor process		90% or more	20 or less	30 or less	—	—
		Contact aeration process						
		Trickling filter process						
		Extended aeration process						
		Conventional activated sludge process						
7		Contact aeration and trickling filter process		—	10 or less	15 or less	—	—
		Coagulation separation process						
8		Contact aeration and activated carbon absorption process		—	10 or less	10 or less	—	—
		Coagulation separation and activated carbon absorption process						
9		Nitrified water recirculation type activated sludge process		—	10 or less	15 or less	20 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
10		Nitrified water recirculation type activated sludge process			10 or less	15 or less	15 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
11		Nitrified water recirculation type activated sludge process			10 or less	15 or less	10 or less	1 or less
		Tertiary treatment type denitrification dephosphorization process						
12	Emission standard under the Water Pollution Control Law	Class: 6 - 11 / 6 - 11 / 6 - 11 / 7 - 11 / 8	COD (mg/ℓ): 60 / 45 / 30 / 15 / 10	SS (mg/ℓ): 70 / 60 / 50 / 15 / 15	n-Hex (mg/ℓ): 20 / 20 / 20 / 20 / 20	pH: 5.8~8.6 / 5.8~8.6 / 5.8~8.6 / 5.8~8.6 / 5.8~8.6	Total coliforms (N/mℓ): 3,000 or less / 3,000 or less / 3,000 or less / 3,000 or less / 3,000 or less	

note: Class 2 and Class 3 were deleted in 2006.



A phosphorous removal type small-scale Johkasou (FRP-made)



A membrane type small-scale Johkasou (FRP-made)

Construction of Johkasou

To ensure that a Johkasou functions as designed, Johkasou should be constructed by a Johkasou installation vendor that is registered by the prefectural governor, being supervised by a certified Johaksou Installation Worker, and complying with the technical standards of Johkasou construction.

As most small-scale Johkasou are made of plastics at factories, when installing this prefabricated Johkasou, the procedure shown in Figure 17 should be observed.

As medium to large-scale Johkasou are mainly built of reinforced concrete at sites of installation, the same precautions taken in constructing an ordinary wastewater treatment facility must be observed.

Johkasou Installation Worker

Earth excavation

●Earth excavation

Excavate a hole of the necessary size to install the Johkasou. Shoring may be required depending on the characteristics of soil or subsoil at the installation site. Excavation on sites with high ground water levels requires dewatering.

Earth excavation

Foundation work

●Foundation work

Lay down a layer of rubble that is sufficiently compacted to keep the Johkasou main unit horizontal and prevent the ground from sinking or rising. After pouring leveling concrete, pour the base-plate reinforced concrete to facilitate the horizontal installation of the Johkasou and to transmit the weight of it and the superstructure to the ground.

Base-plate reinforced concrete

Installation

●Installation

Install the Johkasou in assigned location, making sure that it is leveled.

Water filling & Bckfilling

●Water filling

Fill the Johkasou with tap water to protect it against damage and deformation during backfilling, and then check for leveling and for water leaks.

●Backfilling

First, tamp down the lower half and compact the earth by pouring water. Then, tamp down the upper half in the same way and fill in the space with earth to the bottom level of the inflow and outflow pipes.

Installation (confirmation of inside facilities)

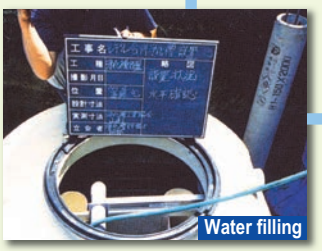
Connecting pipes

●Connecting pipes

After sufficiently compacting the piping pathway section, fill in with earth and connect the inflow and outflow pipes. Pay attention to the gradient of inflow and outflow pipes when installing them. Install the pipes and pit and backfill the earth.

●Floor slab concrete work

Pour concrete on top of the backfilled earth to facilitate maintenance/inspection work, prevent the penetration of rainwater, and keep the Johkasou from rising. This work can also be done after backfilling or connecting pipes.



Water filling

Backfilling

Installing equipment

●Installing auxiliary equipment

Install auxiliary equipment, such as blowers and pumps, in their designated positions. The blower and other equipment that may generate vibration or noise must be installed after preparing the appropriate foundations.

Electrical work

●Electrical work

Install a waterproof power supply specially designed for the Johkasou unit, and be sure to ground it to the earth.

Connecting pipes

Test operation

●Test operation

After construction work is completed, check whether each unit involved in the Johkasou and its auxiliary equipment operates properly. At the same time, also check to ensure the Johkasou is leveled, that there are no water leaks and that the flow of water is normal.

Delivery

●Delivery

Deliver the Johkasou to the Johkasou users together with the necessary documents after confirming that it operates properly. The details of how to use the Johkasou and the managing of maintenance/desludging should be explained to the Johkasou users.

Upper part of concrete slab construction

Figure 17 Construction procedure of small-scale Johkasou

Operation, Maintenance and Inspection of Johkasou

To realize performance in line with the design of Johkasou, the device must be used correctly. The Johkasou manager has a statutory obligation, as the person responsible for the operation of Johkasou, to periodically conduct maintenance and remove the sludge accumulated in the Johkasou as outlined in the Johkasou Act.

Since not every Johkasou manager possesses specialized knowledge regarding maintenance and desludging, the works of maintenance and desludging are mainly entrusted to Johkasou maintenance vendors and Johkasou desludging vendors. Another statutory obligation requires that Johkasou managers receive an annual inspection to evaluate whether the maintenance and desludging were correctly executed and to confirm that the unit is performing as designed. The water quality inspection is executed by an inspection agency specified by the prefectural governor.

Johkasou technicians responsible for operation/maintenance, desludging and legal inspection are Johkasou Operator, Johkasou Desludging Technician and Johkasou Inspector, respectively.

Johkasou Inspector

Legal inspection by Article 7

Purpose
Confirm if the construction/ installation and treatment performance are good.

Contents
- visual inspection
- water quality inspection
- document inspection

Timing of implementation
Three to eight months after starting operation

Responsible organization
Specified inspection agency, which is a public service corporation of the prefecture.

Johkasou Operator

Operation/Maintenance

Purpose
Maintain a normal treatment performance

Contents
- sludge accumulation
- water quality
- mechanical apparatus
- replenish disinfectant

Frequency
Over three times a year, depending on the size and the treatment process

Responsible organization
Johkasou maintenance vendor, which is licensed by the prefectural governor.

Johkasou Desludging Technician

Desludging

Purpose
Recover normal treatment performance by removing sludge regularly

Contents
- removing sludge
- cleansing the Johkasou
- confirming if there are faults or defects inside the Johkasou

Frequency
Once a year

Responsible organization
Johkasou desludging vendor, which is registered by the mayor.

Johkasou Inspector

Legal inspection by Article 11

Purpose
Confirm if the maintenance and desludging is done appropriately, and if the treatment performance is good.

Contents
- visual inspection
- water quality inspection
- document inspection

Frequency
Once a year

Responsible organization
Specified inspection agency, which is a public service corporation of the prefecture.

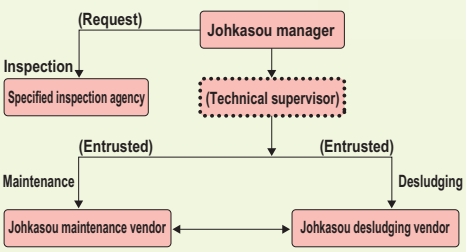


Figure 18 Framework of Johkasou management

Column 6 Johkasou technicians and vendors

Qualifications/vendors	Registrant/ number of vendors	Business content	Legal basis
Johkasou Operator	80,042	Operation and maintenance	Johkasou Act
Johkasou Installation Worker	86,595	Installation/construction	
Johkasou Technical Supervisor	29,794	Management of Johkasou with 501 PE or more	Enforcement regulations of Johkasou Act
Johkasou Desludging Technician	16,021	Desludging	
Registered Johkasou Inspector	1,280	Legal inspection	
Specified Inspection Agency	65	Legal inspection	
Johkasou manufacturer	18	Research, development and manufacture	
Johkasou maintenance vendor	12,435	Operation and maintenance	Johkasou Act
Johkasou desludging vendor	5,291	Desludging	
Johkasou Installation vendor	28,356	Installation/construction	

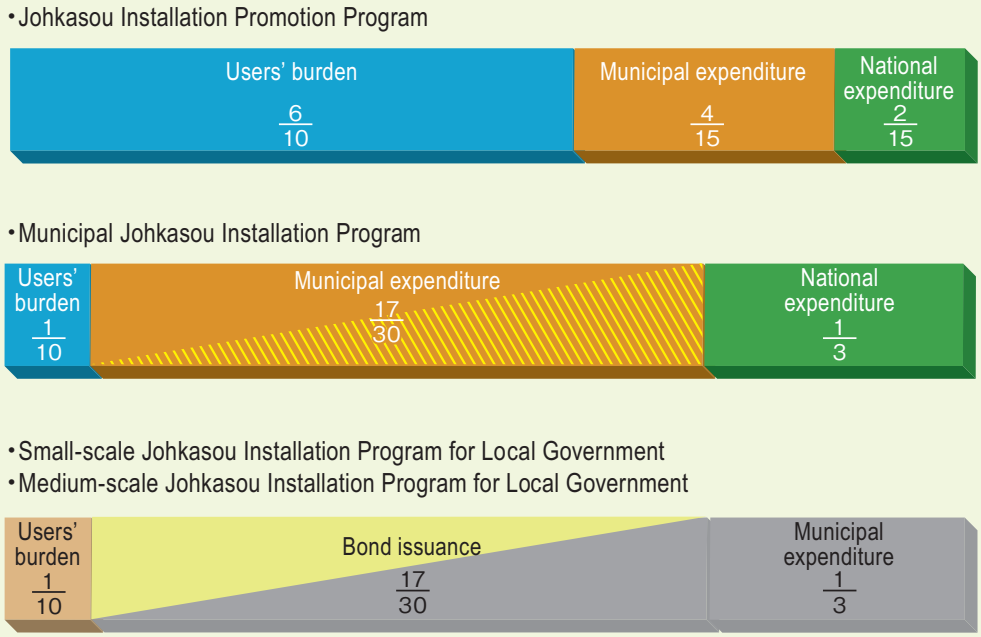
(as of the end of FY2015)

Subsidy Programs for Johkasou Installation

To promote countermeasures for domestic wastewater, Ministry of the Environment launched a subsidy program called 'Johkasou Installation Promotion Program' to support homeowners installing Johkasou in 1987. In 1994, Ministry of the Environment launched another subsidy program called 'Municipal Johkasou Installation Program' to support municipalities installing Johkasou.

There are two other municipal Johkasou installation programs: 'Small-scale Johkasou Installation Program for Local Government' and 'Medium-scale Johkasou Installation Program for Local Government.' Both of these are promoted individually by municipalities as a public enterprise to install small-scale or medium-scale Johkasou for decentralized or centralized treatment, while the municipalities can issue bonds and receive local allocation tax money as part of the installation cost from the Ministry of Internal Affairs and Communication.

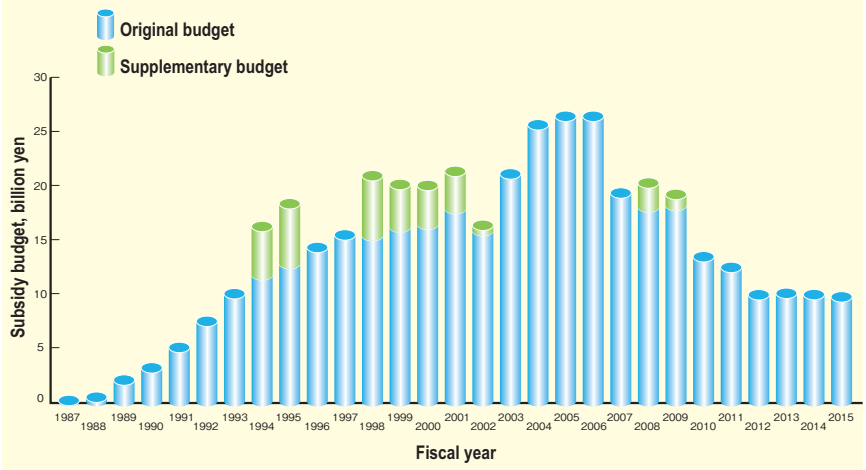
With the introduction of the subsidy programs above, the spread of Johkasou has been promoted greatly.



For example, the cost of installing a Johaksou for 5 PE is supposed to be 840 thousand yen,
In the case of the Johkasou Installation Promotion Program, the user's burden is 504 thousand yen, the government and municipalities pay 336 thousand yen.
In the case of the Municipal Johkasou Installation Program, the user's burden is 84 thousand yen, the government and municipalities pay 756 thousand yen.

Figure 19 Schematics of financial resources of subsidy programs

Column 7 Subsidy budget and maintenance cost



An example of maintenance cost of BOD removal type Johkasou

	A Johkasou for 5 PE	A Johkasou for 7 PE
Annual cost	65,000 yen	81,000 yen
Items		
maintenance fee	21,000 yen	22,000 yen
desludging fee	26,000 yen	35,000 yen
electricity fee	13,000 yen	19,000 yen
inspection fee	5,000 yen	5,000 yen

Development of Night Soil Treatment Technology in Japan

To meet the social needs or to take preemptive measures, various night soil treatment technologies have been developed and put into practical use in Japan.

In 1950s, anaerobic digestion treatment was the major process in night soil treatment facilities. From then, more compact with higher treatment performance facilities were constructed. The facilities became capable of treating not only night soil and Johkasou sludge but also organic wastes with high concentrations, and shifted from waste treatment facilities to recycling facilities by manufacturing biomass, compost fertilizer and other useful products.

The following shows outlines of night soil treatment technologies developed in Japan

Anaerobic digestion treatment :	Anaerobic digestion tanks combined with trickling filter process or activated sludge process; it has advantages of biomass production, production of high fertilizer effect digested sludge with low moisture content
Chemical treatment :	Solid-liquid separation process using flocculant such as metallic salt and hydrated lime, combined with trickling filter process or activated sludge process
Aerobic digestion treatment :	Instead of anaerobic digestion tanks, aerobic digestion tanks are adopted to decrease the odors and make the plant more compact
Standard denitrification treatment :	A biochemical denitrification process for treating night soil diluted by five to ten times with water
High-load denitrification treatment :	Night soil without dilution is treated by high-load denitrification devices, solid-liquid separation devices and flocculation separation devices
Membrane separation high-load denitrification treatment :	Night soil is treated by the high-load denitrification process, membrane separation devices are adopted for solid-liquid separation instead of traditional sedimentation tanks or mechanical devices

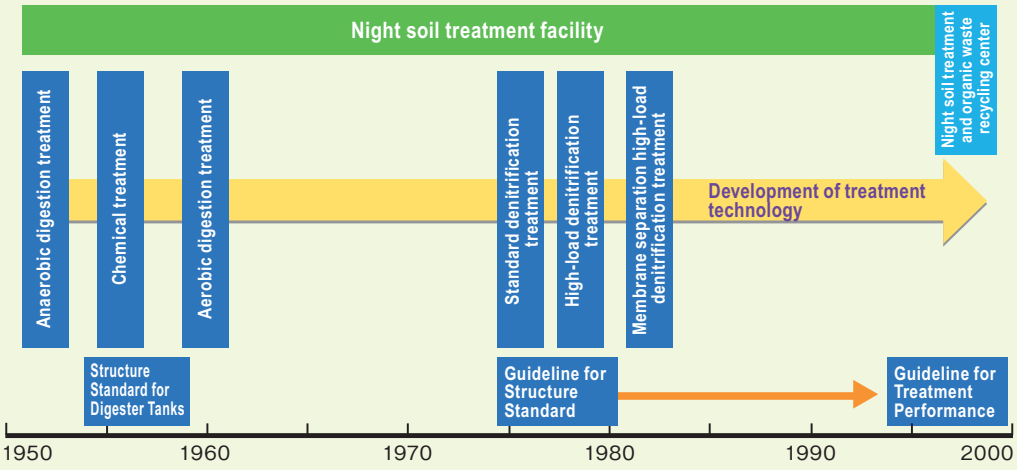


Figure 20 Historical development of night soil treatment technology in Japan

Picture 1 The first large scale night soil treatment plant (Sunamachi plant, capacity 3,600kℓ/day,1954)(6)

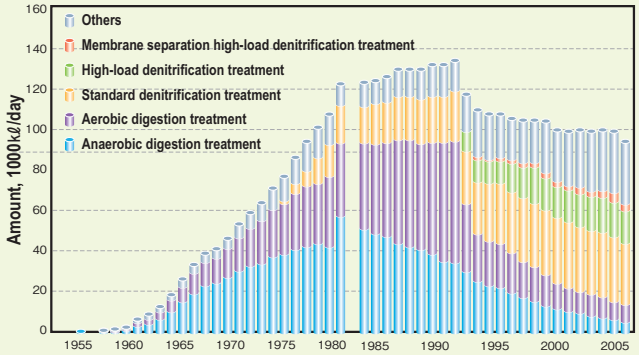


Figure 21 The treated amount of night soil by treatment processes(3)

Table 6 Historical transition of night soil treatment systems

Year	Event
1953	Start of subsidy program for night soil treatment facilities
1956	Notice of structure standard for anaerobic digester tanks
1966	Guidance for maintenance and management of night soil treatment facilities
1977	Guideline for structure of night soil treatment facilities
1979	Revision of guidelines for structure of night soil treatment facilities (two step activated sludge process and flocculation separation process were added)
1981	Revision of guideline for structure of night soil treatment facilities (Johkasou sludge treatment processes were systemized)
1988	Revision of guideline for structure of night soil treatment facilities (high-load denitrification treatment process and advanced treatment processes were added)
1993	Revision of guideline for structure of night soil treatment facilities (effluent BOD concentration was revised to be less than 20mg/ℓ)
1997	Start of subsidy program for night soil treatment and organic wastes recycling center Revision of guideline for structure of night soil treatment facilities (methane manufacturing devices were added)

Sources: (1) From the left side, Paintings of Edo Kakusho; Paintings of Customs of Edo and Meiji eras; Thinking about 'Toilet situation and sanitation culture', Bungeishunshusha; Wakanshenyoshyu, Vol.5 (2) S. Watanabe, Toilets in Edo, Shinchoshenshyo (3)Yuzo Inoue, History and technology of night soil treatment in Japan, J. of Monthly Johkasou (4) Ministry of the Environment, Waste Management in Japan (5) Literature offered by Ministry of Land, Infrastructure, Transport and Tourism (6) Literature offered by Environment Bureau of Tokyo Metropolitan

Ministry of the Environment